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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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IV.—GEOLOGY.

AMONG the philosophers of Greece and Rome we find, even at an early period, germs of geological truth, and—what is of vast importance—an atmosphere in which such germs could grow. These germs were transmitted to Roman thought; an atmosphere of tolerance continued; there was nothing which forbade unfettered reasoning either upon the earth's strata or upon the remains of former life found in them, and under the empire a period of fruitful observation seemed sure to begin.

But, as Christianity took control of the world, there came a great change. The earliest attitude of the Church toward geology and its kindred sciences was indifferent, and even contemptuous. According to the prevailing belief, the earth was a "fallen world," and was soon to be destroyed. Why, then, should it be studied? Why, indeed, give a thought to it? The scorn which Lactantius had cast upon the study of astronomy was extended largely to other sciences. St. Jerome summed up the general feeling of the Church in his time by asserting that the broken and twisted crust of the ruined earth exhibits the wrath of God against human sin. St. Augustine showed this feeling at various times in a very marked degree.*

But the germs of scientific knowledge and thought developed in

* For a compact and admirable statement as to the dawn of geological conceptions in Greece and Rome, see Mr. Lester Ward's masterly essay on palæobotany in the "Fifth Annual Report of the United States Geological Survey," for 1883-'84. For the reference to St. Jerome, see Shields's "Final Philosophy," p. 119; also Lyell's "Introduction to Geology," vol. i, chapter ii. As to the reasons why Greek philosophers did comparatively so little for geology, see D'Archiac, "Géologie," p. 18.

the ancient world could be entirely smothered neither by eloquence nor logic, and St. Augustine himself began an effort to evolve from these germs a growth in science which should be "sacred" and "safe." With this intent he prepared his great commentary on the work of creation, as given in Genesis, beside touching upon the subject in other writings. Once engaged in this work, he gave himself to it more earnestly than any other of the earlier fathers ever did; but his vast powers of research and thought were not directed to actual observation or reasoning upon observation; the key-note of his whole method is seen in his famous phrase, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind."* All his thought was given to studying the letter of the sacred text, and to the application of it by methods purely theological.

Among the many questions he then raised and discussed may be mentioned such as these: "What caused the creation of the stars on the fourth day?" "Were beasts of prey and venomous animals created before or after the fall of Adam? If before, how can their creation be reconciled with God's goodness; if afterward, how can their creation be reconciled to the letter of God's word?" "Why were only beasts and birds brought before Adam to be named, and not fishes and marine animals?" "Why did the Creator not say, 'Be fruitful and multiply,' to plants as well as to animals?"†

As to the creation of animals, Augustine curiously anticipates the Darwinian theory in his statement that birds take their origin in water. As to land animals, he holds that insects were not created "actually" during the six days, but only "potentially and virtually" so, since they sprang afterward from carrion.

Such was the contribution of the greatest of the Latin Fathers to the scientific knowledge of the world, after a most thorough study of the biblical text, and a most profound application of theological reasoning. The results of this contribution were most important. In this, as in so many other fields, Augustine gave direction to the main current of thought in Western Europe, Catholic and Protestant, for nearly thirteen centuries.

In the ages that succeeded, the vast majority of prominent scholars followed him implicitly. Even so strong a man as Pope Gregory the Great yielded to his influence, and such leaders of thought as St. Isidore, in the seventh century, and the venerable Bede, in the eighth, planting themselves upon Augustine's premises, only ventured timidly to extend their conclusions upon lines he had laid down.

In his great work on "Etymologies," Isidore took up Augustine's attempt to bring the creation of insects into satisfactory relations with the book of Genesis, and, adopting the theory of the ancient philoso-

* For citations and authorities on this point, see my chapter on "Meteorology."

† See Augustine, "De Genesi," ii, 13, iii, 13, 15, *et seq.*, ix, 12, *et seq.*

phers, declared that bees are generated out of decomposed veal, beetles out of horse-flesh, grasshoppers out of mules, and scorpions out of crabs. Under the influence of the biblical account of Nebuchadnezzar, which appears to have taken strong hold upon mediæval thought in science, he declared that human beings had been changed into animals, especially into swine, wolves, and owls. As to fossil remains, he, like Tertullian, thought that they resulted from the Flood of Noah.*

In the following century Bede developed the same orthodox traditions in science; but he held with St. Jerome that the reason why God did not pronounce the work of the second day good is to be found in the fact that there is something essentially evil in the number two. As to the Deluge, he discussed the question as to the amount of food taken into the ark, and declared that there was no need of a supply for more than one day, since God could throw the animals into a deep sleep, or otherwise miraculously make one day's supply sufficient.†

The difficulty in making Noah's ark large enough to contain all the animals had begun to be seriously felt even at that period. Origen had dealt with it by supposing that the "cubit" in Noah's time was six times greater. Bede explained Noah's ability to complete such a Herculean task by supposing that he gave to it a hundred years; and he leaned toward diminishing the number of animals taken into the ark, supporting himself upon Augustine's theory of the after development of insects out of carrion. In this way the strain upon faith required in believing that all the animals were literally brought into the ark was somewhat lessened.

The best guess in a geological sense among the mediæval followers of St. Augustine was made by an Irish monkish scholar,‡ who, in order to diminish the difficulty arising from the distribution of animals after the flood, especially in view of the fact that the same animals are found in Ireland as in England, held that various lands now separated were once connected. Fortunately for this theologian, the fact that the kangaroo is only found on a continent in the South Pacific, and so, in accordance with the theory, must either by a single leap have jumped from Mount Ararat to Australia, or have found his way across a causeway temporarily erected between Armenia and the South Pacific continent, had not been discovered.

These general lines of thought upon geology and its kindred science of zoölogy were followed by St. Thomas Aquinas and by the whole body of mediæval theologians, so far as they gave any attention to such subjects.

But there was one influence coming from the Hebrew Scriptures which wrought to mitigate ideas regarding the worthlessness of any study of Nature; this came from the grand utterances in the Psalms

* See Isidore, "Etymologiæ," xi, 4, xiii, 22. † See Bede, "Hexæmeron," i, ii.

‡ The so-called Pseudo-Augustine. His treatise, "De mirabilibus mundi," is usually appended to the works of Augustine.

regarding the beauty and wonders of creation, and we see the glow of this noble poetry radiated upon those whom logic drew away from studies in natural science. Some of the results produced were indeed curious. Thus, in the science of zoölogy, so essentially connected with geology, Vincent de Beauvais and his compeers, while showing a great desire to display to their readers the glories and wonders of Nature, rely in their attempts to do so, not upon observation but upon authority. Neglecting the wonders which the dissection of any animal would have afforded them, they amplified statements found in various mediæval legends, and especially in the lives of the saints. Hence such additions to learning as careful descriptions of the unicorn and dragon mentioned in Scripture, and such statements as that the lion when pursued by hunters effaces his tracks with the end of his tail; that the hyena can talk with shepherds, and changes its sex every year; that a certain bird is born of the fruit of a certain tree when that fruit happens to fall into the water; and innumerable other statements equally valuable.*

Very pious uses were made of this science, especially by monkish writers. The phœnix rising from his ashes proved the doctrine of the Resurrection; the structure and mischief of monkeys proved the existence of demons; the fact that certain monkeys have no tails served to prove that Satan was shorn of his glory; the weasel, which constantly changes its place, was exhibited as a type of man estranged from the word of God, and finding no rest.†

The next great development, mainly under Church guidance, was by means of the scholastic theology. Phrase-making was substituted for investigation. Without the Church and within it wonderful contributions were thus made. In the eleventh century Avicenna accounted for the fossils by suggesting a "stone-making force";‡ in the thirteenth, Albert the Great attributed them to a "formative quality."# In the following centuries some philosophers ventured the idea that they grew from seed, and the Aristotelian doctrine of spontaneous generation was constantly used to prove that these stony fossils possessed powers of reproduction like plants and animals.‖

Still, at various times and places, germs implanted by Greek and Roman thought were warmed into life. The Arabian schools seem to have been less fettered by the letter of the Koran than the contemporary Christian scholars by the letter of the Bible; and to Avicenna belongs the credit of first announcing substantially the modern geological theory of changes in the earth's surface.△

* See Berger de Xivrey, "Traditions tératologiques," and such mediæval books of *exempla* as the "Lumen animæ."

† See Rambaud, "Histoire de la Civilisation française," Paris, 1885, vol. i, pp. 368, 369.

‡ "Vis lapidifica." # "Virtus formativa."

‖ See authorities given in Mr. Ward's essay, as above.

△ For Avicenna, see Lyell and D'Archiac, and from these it appears that at least one

The direct influence of the Reformation was at first unfavorable to scientific progress. Nothing could be more at variance with any scientific theory of the development of the universe than the ideas of the Protestant leaders. The strict adherence to the text of Scripture which made Luther and Melanchthon denounce the idea that the planets revolve about the sun, would naturally be extended to every other scientific statement apparently at variance with the sacred text. There is much reason to believe that the fetters upon scientific thought were closer under the strict interpretation of Scripture made by the early Protestants than they had been under the older Church. The dominant spirit among the reformers is shown by the declaration of Peter Martyr to the effect that, if a wrong opinion should obtain regarding the creation as described in Genesis, "all the promises of Christ fall into nothing, and all the life of our religion would be lost." * Zwingli, broad as his views on other subjects generally were, was closely bound down in this matter, and held to the opinion of the Fathers, that a great floor separated the heavens from the earth, that above it were the waters and angels, and below it the earth and men. The only scope given to independent thought among the reformers was in a few minor speculations regarding the rivers which encompassed the paradise of Adam and Eve, the exact character of the conversation of the serpent with Eve, and the like. † And in the times immediately succeeding the Reformation matters went from bad to to worse. Under Luther and Melanchthon there was some little freedom of speculation, but under their successors there was none; to question any interpretation of Luther came to be thought almost as wicked as to question the literal interpretation of the Scriptures themselves. Examples of this are seen in the struggles between those who held that birds were created entirely from water and those who held that they were created out of water and mud. The accepted belief being that the "waters above the heavens" were contained in a vast receptacle upheld by a solid vault, when Calixt ventured, in interpreting the Psalms, to question this interpretation, he was bitterly denounced as heretical. ‡

Musæus, in the latter part of the sixteenth century, interpreted the account of Genesis to mean that "first God made the heavens for the roof or vault, and left it there on high swinging until three days later he put the earth under it." * In the city of Lubeck, the ancient center of the great Hanseatic League, close at the beginning of the seven-

other scholar found as much trouble from Mohammedan as his contemporaries found from Christian religion.

* See his commentary on Genesis, cited by Zöckler, "Geschichte der Beziehungen zwischen Theologie und Naturwissenschaft," vol. i, p. 690.

† See citations in Zöckler, vol. i, p. 693.

‡ See Zöckler, vol. i, p. 679.

* See Musæus, "Auslegung des ersten Buchs Mosy," Magdeburg, 1576, cited by Zöckler, vol. ii, pp. 673–677, 761.

teenth century, Pfeiffer, "General Superintendent" or bishop in those parts, published a book entitled "Pansophia Mosaica," calculated, as he believed, to beat back science forever. In a long series of declamations he insisted that in the strict text of Genesis alone is safety; that it contains all wisdom and knowledge, human and divine; that twenty-eight articles of the Augsburg Confession are to be found in it; that it is an arsenal of arguments against all sects and sorts of "Atheists, Heathen, Jews, Turks, Tartars, Papists, Calvinists, Socinians, and Baptists"; the source of all sciences and arts, including law, medicine, philosophy, and rhetoric; "the source and essence of all histories and all professions, trades, and works"; "an exhibition of all virtues and vices"; "the origin of all consolation."* This being the case, who could care to waste time on the study of material things and give thought to the structure of the world? Above all, who, after such a proclamation by such a ruler in the Lutheran Israel, would dare to talk of the "days" mentioned in Genesis as "periods of time"; or of the "firmament" as not meaning a solid vault over the universe; or of the "waters above the heavens," as not contained in a vast cistern supported by the heavenly vault; or of the "windows of heaven" as a figure of speech?

In England the same spirit was shown even as late as the time of Sir Matthew Hale. We find in his book on the "Origination of Mankind," published in 1685, the strictest devotion to a theory of creation based upon the mere letter of Scripture, and a complete incapacity for the attainment of knowledge regarding the earth's origin and structure by any scientific process.

Still, while the Lutheran, Calvinistic, and Anglican reformers clung to literal interpretations of the sacred books, and turned their faces away from scientific investigation, it was among their contemporaries at the coming in of the modern period with the revival of learning that there began to arise fruitful thought in this field. Then it was, about the beginning of the sixteenth century, that Leonardo da Vinci, as great a genius in science as in art, broached the true idea as to the origin of fossil remains; and his compatriot, Fracastoro, developed this on the modern lines of thought. Others in other parts of Europe took up the idea, and, while mixing with it many crudities, evolved from it more and more truth. Toward the end of the sixteenth century Bernard Palissy, in France, took hold of it with the same genius which he showed in artistic creation; but, remarkable as were his assertions of scientific realities, they could gain little hearing. Theologians, philosophers, and even some scientific men of value, under the sway of scholastic phrases, insisted upon such explanations as that fossils were the product of "fatty matter set into a fermentation by heat"; or of a "lapidific juice";† or of a "seminal air";‡ or of a "tumultuous movement of terrestrial exhalations"; and there

* See Zöckler, vol. i, pp. 688, 689. † "Succus lapidificus." ‡ "Aura seminalis."

was a prevailing belief that fossil remains, in general, might be brought under the head of "sports of Nature," a pious turn being given to this phrase by the suggestion that these "sports" were in accordance with some inscrutable purpose of the Almighty.

Such remained a leading orthodox mode of explanation in the Church, Catholic and Protestant, for centuries.

But the better scientific method could not be entirely suppressed; and, near the beginning of the seventeenth century, De Clave, Bitaud, and De Villon revived it in France. Straightway, the theological faculty of Paris protested against the scientific doctrine as unscriptural, destroyed the offending treatises, banished their authors from Paris, and forbade them to live in towns or enter places of public resort.*

The champions of science, though repressed for a time, quietly labored on, and especially in Italy. Half a century later, Steno, a Dane, and Scilla, an Italian, went still further in the right direction; and, though they and their disciples took great pains to throw a tub to the whale, in the shape of sundry vague concessions based upon the book of Genesis, geological truth was more and more developed by them.

In France, the old theological spirit remained more powerful. At the middle of the eighteenth century Buffon made another attempt to state simple geological truths; but the theological faculty of the Sarbonne dragged him at once from his high position, forced him to recant ignominiously, and to print his recantation. This humiliating document reminds us painfully of that forced upon Galileo nearly a hundred years before. It runs as follows: "I declare that I had no intention to contradict the text of Scripture, that I believe most firmly all therein related about the creation, both as to order of time and matter of fact. I abandon everything in my book respecting the formation of the earth, and generally all which may be contrary to the narrative of Moses."

It has been well observed by one of the greatest of modern authorities that the doctrine which Buffon thus "abandoned" is as firmly established as the earth's rotation upon its axis.† Yet one hundred and fifty years were required to secure for it even a fair hearing; the prevailing doctrine of the Church continued to be that "in the beginning God made the heavens and the earth"; that "all things were made at the beginning of the world"; and that to say that stones and fossils were made before or since "the beginning" is contrary to Scripture. Again, we find theological substitutes for scientific explanation ripening into phrases more and more hollow, making fossils "sports of Nature," or "mineral concretions," or "creations of plastic force," or "models" made by the Creator before he had fully decided upon the best manner of creating various beings.

* See Morley, "Life of Palissy the Potter," vol. ii, p. 315, *et seq.*

† See citation and remark in Lyell's "Principles of Geology," chap. iii, p. 57.

Of this period, when theological substitutes for science were carrying all before them, there still exists a monument commemorating at the same time a farce and a tragedy. This is the work of Johann Beringer, professor in the University of Würzburg and private physician to the Prince-Bishop—the treatise bearing the title "Lithographiæ Wirceburgensis specimen primum," "illustrated with the marvelous likenesses of two hundred figured or rather insectiform stones." Beringer, for the greater glory of God, had previously committed himself so completely to the theory that fossils are simply "stones of a peculiar sort, hidden by the Author of Nature for his own pleasure,"* that some of his students determined to give his faith in that pious doctrine a thorough trial. They therefore buried in a place where he was wont to search for specimens a store of sham fossils in baked clay—of their own manufacture—including not only plants, reptiles, and fishes of every sort that their knowledge or imagination could suggest, but even Hebrew and Syriac inscriptions, one of them the name of the Almighty. The joy of the pious professor on unearthing these proofs of the immediate agency of the finger of God in creating fossils knew no bounds. At great cost he prepared this book, whose twenty-two elaborate plates of *fac-similes* were forever to settle the question in favor of theology and against science. Prefixed to the work was an allegorical title-page, wherein not only the glory of his own sovereign, but that of heaven itself, was pictured as based upon a pyramid of these miraculous fossils. So robust was his faith that not even a premature exposure of the fraud could dissuade him from its publication. Dismissing in one contemptuous chapter this exposure as the slander of his rivals, he appealed to the learned world. But the shout of laughter that welcomed the work soon convinced even its author. In vain did he try to suppress it; and, according to tradition, having wasted his fortune in vain attempts to buy up all the copies of it, and, being taunted by the rivals whom he had thought to overwhelm, he died of chagrin. Even death did not end his misfortunes. The copies of the first edition having been sold by a graceless descendant to a Leipsic bookseller, a second edition was brought out under a new title, and this, too, is now much sought as a precious memorial of human folly.†

But even this discomfiture did not end the idea which had caused it, for, although some latitude was allowed among the various theologico-scientific explanations, it was still held meritorious to believe that all fossils were placed in the strata on one of the creative days by the

* See Beringer's "Lithographiæ," etc., p. 91.

† See Carus, "Geschichte der Zoologie," Munich, 1872, p. 467, note, and Reusch, "Bibel und Natur," p. 197. A list of the authorities upon this episode, with the text of one of the epigrams circulated at poor Beringer's expense, is given by Dr. Reuss in the "Serapeum" for 1852, p. 203. The book itself (the original impression) is in the White Library at Cornell University. For Beringer himself, see especially the encyclopædia of Ersch and Gruber, and the "Allg. deutsche Biographie."

hand of the Almighty, and that this was done for some mysterious purpose, probably for the trial of human faith.

Strange as it may at first seem, the theological war upon the true scientific method in geology was waged more fiercely in Protestant countries than in Catholic. The older Church had learned by her earlier wretched mistakes, especially in the cases of Copernicus and Galileo, what dangers to her claim of infallibility lay in meddling with a growing science. In Italy, therefore, comparatively little opposition was made, while England furnished the most bitter opponents to geology so long as the controversy could be maintained and the most active negotiators in patching up a truce on the basis of a sham science afterward. The Church of England did, indeed, produce some noble men, like Bishop Clayton and John Mitchell, who stood firmly by the scientific method; but these appear generally to have been overwhelmed by a chorus of churchmen and dissenters, whose mixtures of theology and science, sometimes tragic in their results and sometimes comic, are among the most instructive things in modern history.*

We have already noted that there are generally three periods or phases in a theological attack upon any science.† The first of these is marked by the general use of scriptural texts and statements against the new scientific doctrine; the third by attempts at compromise by means of far-fetched reconciliations of textual statements with ascertained fact; but the second or intermediate period between these two is frequently marked by the pitting against science of some great doctrine in theology. We saw this in astronomy when Bellarmin and his followers insisted that the scientific doctrine of the earth revolving about the sun is contrary to the theological doctrine of the incarnation. So now against geology it was urged that the scientific doctrine that fossils represent animals which died before Adam contradicts the theological doctrine of Adam's fall and the statement that "death entered the world by sin."

In this second stage of the theological struggle with geology, Eng-

* For a comparison between the conduct of Italian and English ecclesiastics as regards geology, see Lyell, "Principles of Geology," tenth English edition, vol. i, p. 33. For a philosophical statement of reasons why the struggle was more bitter and the attempt at deceptive compromises more absurd in England than elsewhere, see Maury, "L'ancienne Académie des Sciences," second edition, p. 152. For very frank confessions of the reasons why the Roman Catholic Church has become more careful in her dealings with science, see Roberts, "The Pontifical Decrees against the Earth's Movement," London, 1885, especially pp. 94 and 132, 133, and St. George Mivart's article in the "Nineteenth Century" for July, 1885. The first of these gentlemen is a Roman Catholic clergyman, and the second an eminent layman of the same church, and both admit that it was the Pope, speaking *ex cathedra*, who erred in the Galileo case; but their explanation is that God allowed the Pope and Church to fall into this grievous error, which has cost so dear, in order to show once and for all that the Church has no right to decide questions in science.

† See "The Warfare of Science," original edition, for a discussion of this point.

land was especially fruitful in champions of orthodoxy. First among these may be named Thomas Burnet. In the last quarter of the seventeenth century, just at the time when Newton's great discovery was given to the world, Burnet issued his "Sacred Theory of the Earth." His position was commanding; he was a royal chaplain and a cabinet officer of high standing. Planting himself upon the famous text in the second epistle of Peter,* he declares that the flood had destroyed the old and created a new world. The Newtonian theory he refuses to accept. In his theory of the deluge he lays less stress upon the "opening of the windows of heaven" than upon the "breaking up of the fountains of the great deep." On this latter point he comes forth with great strength. His theory is that the earth is hollow, and filled with fluid like an egg. Mixing together the texts in Genesis and in the second epistle of Peter, the theological doctrine of the "Fall," an astronomical theory regarding the ecliptic, and sundry notions caught from Descartes, he insisted that, before sin brought on the deluge, the earth was of perfect mathematical form, smooth and beautiful, "like an egg," with neither seas nor islands nor valleys nor rocks, "with not a wrinkle, scar, or fracture," and that all creation was equally perfect.

In the second book of his great work Burnet went still further. As in his first book he had mixed his texts of Genesis and St. Peter with Descartes, he now mixes the account of the Garden of Eden in Genesis with heathen legends of the golden age, and concludes that before the flood there was, over the whole earth, perpetual spring, disturbed by no rain more severe than the falling of the dew.

In addition to his other grounds for denying the earlier existence of the sea, he assigns the reason that, if there had been a sea before the Deluge, sinners would have learned to build ships, and so, when the Deluge set in, could have saved themselves.

The work was written with much power, and attracted universal attention. It was translated into various languages, and called forth a multitude of supporters and opponents in all parts of Europe. Strong men rose against it—especially in England—and among them a few dignitaries of the Church; but the Church generally hailed the work with joy. Addison praised it in a Latin ode, and for nearly a century it exercised a strong influence upon European feeling. It aided to plant more deeply than ever the theological opinion that the existing earth is now but a ruin; whereas, before sin brought on the Flood, it was beautiful in its "egg-shaped form," and free from every imperfection.

A few years later came another writer of the highest standing—William Whiston, professor at Cambridge, who in 1696 published his "New Theory of the Earth." Unlike Burnet, he endeavored to avail himself of the Newtonian idea, and brought in, to aid the geological

* See II Peter, iii, 6.

catastrophe caused by human sin, a comet, which opened "the fountains of the great deep."

But, far more important than either of these champions, there arose in the eighteenth century, to aid in the subjection of science to theology, three men of extraordinary power—John Wesley, Adam Clarke, and Richard Watson. All three were men of extraordinary intellectual gifts, the purest character, and the noblest purpose; and the first-named one of the greatest men in English history. Yet we find them in geology hopelessly fettered by the mere letter of Scripture, and by a temporary phase in theology. As in regard to witchcraft and the doctrine of comets, so in regard to geology, this theological view drew Wesley into enormous error.* The great doctrine which Wesley, Watson, Clarke, and their followers thought it especially necessary to uphold against geologists was, that death entered the world by sin—the first transgression of Adam and Eve. The extent to which the supposed necessity of upholding this doctrine carried Wesley seems now almost beyond belief. Basing his theology on the declaration that the Almighty after creation found the earth and all created things "very good," he declares in his sermon on the "Cause and Cure of Earthquakes," that no one who believes the Scriptures can deny that "sin is the moral cause of earthquakes, whatever their natural cause may be." Again, he declares that earthquakes are the "effect of that curse which was brought upon the earth by the original transgression." Bringing into connection with Genesis the declaration of St. Paul that "the whole creation groaneth and travaileth together in pain until now," he finds additional scriptural proof that the earthquakes were the result of Adam's fall. He declares, in his sermon on "God's Approbation of His Works," that "before the sin of Adam there were no agitations within the bowels of the earth, no violent convulsions, no concussions of the earth, no earthquakes, but all was unmoved as the pillars of heaven. There were then no such things as eruptions of fires; no volcanoes or burning mountains." Of course, a science which showed that earthquakes had been in operation for ages before the appearance of man on the planet, and which showed, also, that those very earthquakes which he considered as curses resultant upon the Fall were really blessings, producing the fissures in which we find to-day those mineral veins so essential to modern civilization, was entirely beyond his comprehension. He insists that earthquakes are "God's strange works of judgment, the proper effect and punishment of sin."

So, too, as to death and pain. In his sermon on the "Fall of Man" he takes the ground that death and pain entered the world by Adam's transgression, insisting that the carnage now going on among animals is the result of Adam's sin. Speaking of the birds, beasts,

* For his statement that "the giving up of witchcraft is in effect the giving up of the Bible," see Wesley's "Journal," 1766–'68.

and insects, he says that, before sin entered the world by Adam's fall, "none of these attempted to devour or in any way hurt one another"; that "the spider was then as harmless as the fly and did not then lie in wait for blood."* Here, again, Wesley arrayed his early followers against geology, which reveals, in the fossil remains of carnivorous animals, pain and death countless ages before the appearance of man. The half-digested fragments of weaker animals within the fossilized bodies of the stronger have destroyed all Wesley's arguments in behalf of his great theory.

Dr. Adam Clarke held similar views. He insisted that thorns and thistles were given as a curse to human labor, on account of Adam's sin, and appeared upon the earth for the first time after Adam's fall. So, too, Richard Watson, the most prolific writer of the great evangelical reform period, and the author of the "Institutes," the standard theological treatise in the evangelical army, says, in a chapter treating of the Fall, and especially of the serpent which tempted Eve: "We have no reason at all to believe that the animal had a serpentine form in any mode or degree until his transformation. That he was then degraded to a reptile, to go upon his belly, imports, on the contrary, an entire alteration and loss of the original form." All that admirable adjustment of the serpent to its environment which delights naturalists, was to Adam Clarke simply an evil result of the sin of Adam and Eve. Yet here again geology was obliged to confront theology in revealing the *python* in the Eocene—ages before man appeared.†

The immediate results of such teaching by such men was to throw many who would otherwise have resorted to observation and investigation back upon scholastic methods. Again reappears the old system of solving the riddle by phrases. In 1733, Dr. Theodore Arnold urged the theory of "models," and insisted that fossils result from "infinitesimal particles brought together in the creation to form the outline of all the creatures and objects upon and within the earth"; and Arnold's work translated into German gained wide acceptance.‡

Such was the influence of this succession of great men that toward the close of the last century the English opponents of geology on biblical grounds seemed likely to sweep all before them. Cramping our whole inheritance of sacred literature within the rules of an historical compend, they showed the terrible dangers arising from the revelations of geology, which make the earth older than the six thousand years required by Archbishop Usher's interpretation of the Old Testament. Nor was this feeling confined to ecclesiastics. Williams, a thoughtful layman,

* See Wesley's sermon on "God's Approbation of His Works," 11th and 12th parts.

† See "Westminster Review," October, 1870, article on "John Wesley's Cosmogony," with citations from Wesley's "Sermons," Watson's "Institutes of Theology," Adam Clarke's "Commentary on the Holy Scriptures," etc.

‡ See citation in Mr. Ward's article, as above, p. 390.

declared that such researches led to infidelity and atheism, and are "nothing less than to depose the Almighty Creator of the universe from his office." The poet Cowper, one of the mildest of men, was also roused by these dangers, and in his most elaborate poem wrote:

> "Some drill and bore
> The solid earth, and from the strata there
> Extract a register, by which we learn
> That he who made it, and revealed its date
> To Moses, was mistaken in its age!"

Howard summoned England to oppose "those scientific systems which are calculated to tear up in the public mind every remaining attachment to Christianity."*

While this great attack upon geological science by means of the dogma of Adam's fall was kept up, the more general attack by the literal interpretation of the text was continued. The legendary husks and rinds of our sacred books were insisted upon as equally precious and nutritious with the great moral and religious truths which they envelop. Especially precious were the six days—each "the evening and the morning"—and the exact statements as to the time when each part of creation came into being. To save these the struggle became more and more desperate.

Difficult as it is to realize it now, within the memory of many now living the battle was still raging most fiercely in England, and both kinds of artillery usually brought against a new science were in full play, and filling the civilized world with their roar.

About forty years ago, the Rev. J. Mellor Brown, the Rev. Henry Cole, and others, were hurling at all geologists alike, and especially at such Christian divines as Dr. Buckland and Dean Conybeare and Pye Smith, and such religious scholars as Professor Sedgwick, the epithets of "infidel," "impugner of the sacred record," and "assailant of the volume of God."†

The favorite weapon of the orthodox party was the charge that the geologists were "attacking the truth of God." They declared geology "not a subject of lawful inquiry," denouncing it as "a dark art," as "dangerous and disreputable," as "a forbidden province," as "infernal artillery," and as "an awful evasion of the testimony of revelation."‡

This attempt to scare men from the science having failed, various other means were taken. To say nothing about England, it is humiliating to human nature to remember the annoyances, and even trials, to which the pettiest and narrowest of men subjected such Christian scholars in our own country as Benjamin Silliman and Edward Hitchcock and Louis Agassiz.

But it is a duty and a pleasure to state here that one great Chris-

* See Lyell, "Introduction."

† For these citations, see Lyell, "Principles of Geology," introduction.

‡ See Pye Smith, D. D., "Geology and Scripture," pp. 156, 157, 168, 169.

tian scholar did honor to religion and to himself by quietly accepting the claims of science and making the best of them, despite all these clamors. That man was Nicholas Wiseman, better known afterward as Cardinal Wiseman. The conduct of this pillar of the Roman Catholic Church contrasts admirably with that of timid Protestants, who were filling England with shrieks and denunciations.*

And here let me note that one of the most interesting skirmishes in this war was made in New England. Professor Stuart, of Andover, justly honored as a Hebrew scholar, declared that to speak of six periods of time for the creation was flying in the face of Scripture; that Genesis expressly speaks of six days, each made up of "the evening and the morning," and not six periods of time.

To him replied a professor in Yale College, James Kingsley. In an article admirable for keen wit and kindly temper, he showed that Genesis speaks just as clearly of a solid firmament as of six ordinary days, and that, if Professor Stuart had got over one difficulty and accepted the Copernican theory, he might as well get over another and accept the revelations of geology. The encounter was quick and decisive, and the victory was with science and our own honored Yale.†

But perhaps the most singular attempt against geology was made by a fine specimen of the English Don—Dean Cockburn, of York—to *scold* its champions out of the field. Having no adequate knowledge of geology, he opened a battery of abuse. He gave it to the world at large by pulpit and press; he even inflicted it upon leading statesmen by private letters.‡ From his pulpit in York Minster, Mary Somerville was denounced coarsely, by name, for those studies in physical geography which have made her honored throughout the world.#

But these weapons did not succeed; they were like Chinese gongs and dragon-lanterns against rifled cannon, and we are now to look at a very different chapter in this war. This chapter will form the next subject of our study.

* Wiseman, "Twelve Lectures on the Connection between Science and Revealed Religion," first American edition, New York, 1837. As to the comparative severity of the struggle regarding astronomy, geology, etc., in Catholic and Protestant countries, see Lecky, "England in the Eighteenth Century," chap. ix, p. 525.

† See "Silliman's Journal," vol. xxx, p. 114.

‡ Professor Goldwin Smith informs me that the papers of Sir Robert Peel, yet unpublished, contain very curious specimens of these epistles.

See "Personal Recollections of Mary Somerville," Boston, 1874, pp. 139 and 375. Compare with any statement of his religious views that Dean Cockburn was able to make, the following from Mrs. Somerville: "Nothing has afforded me so convincing a proof of the Deity as these purely mental conceptions of numerical and mathematical science which have been, by slow degrees, vouchsafed to man—and are still granted in these latter times by the differential calculus, now superseded by the higher algebra—all of which must have existed in that sublimely omniscient mind from eternity." (See "Personal Recollections," pp. 140, 141.)

PROGRESS AT PANAMA.

By CHARLES C. ROGERS,
LIEUTENANT, UNITED STATES NAVY.

ON the 6th of last March the United States steamer Galena reached Aspinwall after a cruise in the Windward and the Leeward Islands. Before her departure from Norfolk in January, I was directed by the Navy Department to visit the works of the canal upon our arrival at Aspinwall. M. Charles de Lesseps, accompanied by M. Romaire, his secretary, M. Cottu, administrator of the canal, and by other officials from the general office in Paris, with M. Jacquier, director-general of the works, were then occupying the handsome residence in the French quarter of Aspinwall, that is usually assigned to the president of the company during his visits to the Isthmus. They had arrived from France five days before the Galena from the Spanish Main, and were to inspect the canal and arrange with the contractors for the future progress of the works. On the 9th I called upon M. de Lesseps and the director-general, stated my instructions from the Navy Department, and requested permission to visit the canal and to obtain from the contractors full information concerning their respective fields of work. My reception by these gentlemen was most cordial, and was appreciated particularly as an extension of hospitality and civility to an officer of the United States Navy. M. de Lesseps assented readily to my request, assuring me that there was nothing to conceal, and that it was the wish of the company that our Government should know the exact condition of the works and their prospects of completion. He also invited me to accompany him as his guest during his tour of inspection. On reporting the result of my visit to Commander Colby M. Chester, commanding the Galena, I was permitted to accept the invitation so kindly extended.

M. de Lesseps had inspected the 17 kilometres of canal open to water, and on the 10th I proceeded with him by special train to Bohio-Soldado, reserving my visit to the sections of Colon and Gatun for a later date. The inspection thus begun lasted nearly three weeks. I saw every foot of the canal, including the dam at Gamboa and the deflections of the Chagres and the Rio Grande.

Its length from Colon to the Isle of Naos, near Panama, will be 74 kilometres; its width at the surface will be 40 metres, and at the bottom 22 metres; its depth will be 9 metres. The line of works is separated into five divisions, the first of which is 26·35 kilometres in length, and comprises the sections of Colon, Gatun, and Bohio-Soldado. It is under the control of the American Contracting and Dredging Company, which owns a capital of $2,000,000. Mr. H. B. Slaven is president of the company, and Mr. M. A. Slaven general manager on

the Isthmus. Messrs. Vignaud, Barbaud, Blanleuil & Co. have the second division, which includes the Tavernilla, San Pablo, Gorgona, and Matachin sections, and is 17·65 kilometres long. They have built several railways in France, and are experienced in the construction of internal canals. The third falls to the Société de Travaux Publics et Constructions, which has a capital of $600,000, and is known in France and Brazil for successful railway work; it consists of the sections of Obispo and Emperador, and is 9·6 kilometres long. The fourth, or section of Culebra, extends over 3·4 kilometres, and is controlled by the young and energetic firm of Artigue, Sonderegger & Co.; and Messrs. Baratoux, Letellier & Co. have agreed to open the last division to the waters of the Pacific within the next two years. It is 17 kilometres long, and extends from the Culebra to Panama. The company has also established three *physical* divisions, each with reference to the engineering problems involved. The first is 44 kilometres long, and extends from Colon to the Gamboa hills at Matachin, the difficulty lying in the vicinity of the Chagres. The second lies between Gamboa and the end of the Culebra; it contains the highest summits and the greatest quantity of rock, and it will be the line of deepest cuts. The third extends from the Culebra to the Pacific; here the earth will admit of dredging throughout, but the Rio Grande must be deflected from the line of the canal.

The first division begins at Colon with a terre-plein that was formerly the site of a marsh, containing 236,000 cubic metres of earth, and surrounded by a sea-wall; the terre-plein protects the entrance of the canal from the waves that would enter otherwise from the Bay of Limon. It is the site also of the village of Christoval-Colon, where the offices and quarters of the section employés are found.

As the Bay of Limon is exposed to the sea and to the gales of this region, the company is making a new harbor, which is styled the port of Colon. It lies south of the terre-plein, and, when complete, will be formed by Fox River and the expansion of the first 3 kilometres of the canal into a basin. The width of the entrance will be 800 metres; thence to the six-hundredth metre of length, the breadth of the basin will decrease to 500 metres, and will remain uniform as far as the second kilometre, whence it will narrow gradually to the third, where the normal surface width of 40 metres begins. A curved breakwater of 1,500 metres length will prolong the right bank into the bay, and will further protect the port from winds and waves. The new port will afford security to vessels and every facility of wharfage for handling cargo.

The canal is open to water as far as the seventeenth kilometre from Colon, except at the Mindi hills, where a cut of 1,080 metres remains to be completed. Its width for the first 500 yards is 225 metres; throughout the remainder of the basin it varies from 175 to 80 metres, and finally narrows to the normal at the third kilometre. The delay

in opening the Mindi cut is due to the wish to complete the excavation of rocks, and thus render submarine blasting unnecessary. Of the eleven dredges at work in this division, four are European, and vary from 60 to 180 horse-power; the remaining seven are American, of 240 horse-power, their maximum capacity of excavation being 6,000 cubic metres per day. But repairs to machinery, rains, stoppage during the extreme heat of the day and at night, and other delays that can not be remedied, have reduced the daily yield to 3,000 cubic metres.

The level of the remaining bed of the first division is from 4 to 10 metres above the sea. Part of a hill near Bohio remains at the elevations of 20 and 28 metres.

The Chagres is both the upper and the lower limit of the second division, and crosses it seventeen times in its length of 17 kilometres. The average level is 12 metres above the sea, except in a single hill of 25 metres height and in a sudden rise to the same elevation at the end of the division. The excavators are moved on railway-tracks by an engine of 8 to 10 horse-power, and empty their buckets into cars on adjacent rails. Every facility for dredging is presented by the Chagres River, the depth of which is such that dredges can be put at each crossing.

Just within the third division is the Gamboa hill, where occurred the great explosion of 1886 in honor of M. Ferdinand de Lesseps. The charge was 8,250 pounds of dynamite and powder, and blew out 30,000 cubic metres of material. Farther on is the Corrosita, still 45 metres above the sea. But the most remarkable feature of the division is the great *barrage* at Gamboa. Its central line will cross the Chagres between the Cerro Obispo and the Cerro Santa Cruz. Its length at the base will be 300 metres, its height 35 metres, and, with a reveted slope of four to one, it will contain 10,000,000 cubic metres of rock and clay. No excavation is needed for the foundation; a bridge is now building across the valley, and from it trains will discharge into the valley below their loads of rock and earth excavated from the Corrosita and neighboring sections. The pressure of water in the basin will seal the dam by forcing the clay into the interstices of the rock-mass, and by deposits brought down by the river. The capacity of the basin will be one billion cubic metres, or double the accumulation of waters during the worst rainy season. Nature has furnished the other walls of this reservoir in the ridges on each side of the Chagres, and in the natural ascent of the valley toward Cruces. The outlet of the basin will be a derivation of the Chagres around the hills of Barucco and Carga-Plata to the bend north of the forty-fourth kilometre; the outflow will depend upon the height of the water in the basin, but it will never be such that, when coupled even with the drainage of the remaining water-shed of the Upper Chagres, floods can occur in the lower course of the river.

In the last days of November the water usually rises to eight metres above the ordinary level. In the valley of the Chagres the annual rainfall is 3 metres. The average discharge of the river during the wet season is 134 cubic metres per second, and 666 during the floods. In the exceptional rise of 1879 it reached 1,930 cubic metres, but it must be remembered that such discharges seldom last more than forty-eight hours; for, as Lieutenant Kimball states in his valuable report just published, "The floods are of short duration, showing that they result from large local rainfall, and not from extensive watershed." When the *barrage* and derivations are completed, I believe that the problem of the Chagres will be solved.

Another interesting feature of this division is the two aqueducts that will be built near Emperador to carry the waters from the mountain valleys on the northern and eastern side across the canal into the Obispo River. Their elevation will be the present levels of these sites, and vessels will pass under them. The bed of the cuttings at the end of the division have now a level of 55 metres.

The original elevation of the Culebra in the plane of the axis of the canal was 108 metres; the cuttings have reduced it to 78 metres. The width of the cut at the summit is 300 metres, the slope of the sides being forty-five degrees. But a serious question at this point lies in the accumulation of material by wash, land-slides, and fissures. Last year 78,000 cubic metres of earth fell into the canal. The hill on the right side of the cut is formed of dolerite and sand, and no wash or slip can occur from it. But on the left side I found strata of clay covered with a mixture of alluvium, sand, and conglomerate. During the wet season this deposit becomes saturated, and the increased weight, coupled with the dip of the strata, causes it to slip over the smooth surface of the clay into the canal. The clay in turn contracts during the dry season, fissures result, and hence another source of land-slides; and the natural wash of torrential rains is a third cause of deposit in the bed of the cut.

But a far more serious problem apparently is the annual movement of this side toward the axis of the canal. It varies from 12 to 18 inches, and the contractors acknowledge that its remedy may require heavy expenditure for increased slope, if nothing more. As yet, however, this can not be regarded as an *actual* danger. The removal of so much material from the Culebra must affect the position of the center of gravity of the mass, and it may be that this movement results from a settling to the new conditions. This is the more hopeful view, and a reasonable one, but there is greater cause to fear that this is a movement of the whole hill-side, and not an earth-slide from the higher portions of the bank. The clay of Culebra is of the same bed as the "greasy" or slipping clay of the adjoining section of Paraiso. Referring to the latter, Lieutenant Kimball says its movement "in some places carries one bank almost intact across the cut with the top sur-

face unbroken, and with the vegetation undisturbed." Again, "The effect of the move of the soil was very curious; at one point the bottom of the deflection cut had *risen* 3 metres where the greasy clay had forced itself underneath, and at another I saw a surveying picket which had moved *out of line* 2½ metres, where there was no break in the top soil." To my mind, the deep cut of the Culebra is the great problem of the enterprise; already its side threatens to bar the way.

Leaving this puzzle to the contractors, and looking toward Panama, the first third of the last division descends gradually to 4 metres level at Pedro Miguel; the middle portion forms a plane from 5 to 8 feet above the sea, and over the last 6 kilometres flow the waters of the Pacific to an average depth of 5 metres, and reaching the maximum as Naos is approached.

At Colon the highest tides do not exceed 58 centimetres, or 23 inches, while at Panama high tides reach 4 metres, or 13 feet, and spring tides even 6 metres, or 20 feet. That vessels may pass at all stages of tide, the depth of the canal from Naos to the present crossing of the Rio Grande beyond Corozal—9·4 kilometres—will be 9 metres at lowest ebb.

The company has consulted the French Academy of Sciences concerning the probable effect of this difference of tide-level on the canal, and has been told that a lock or tidal gate will not be needed. The director-general does not oppose this view, but thinks that an answer to this question at present must be based on theory—that, as excavations progress, the effect must be watched; and that upon the knowledge obtained the decision must rest. Plans for a tidal gate have been prepared, and, if needed, it will be placed at the Boca, near Panama.

The line of the canal is crossed twenty-eight times by the Chagres between Gamboa and Colon, and thirteen times by the Rio Grande between Culebra and Panama. To avoid the dangers of current and overflow that would exist if these streams entered the canal, deflections are excavated to carry them to the sea in beds on each side of the canal. The deflections of the Upper Chagres will drain the Gamboa basin and the water-shed north of the canal, and will discharge their waters into the Boca Grande, east of Colon; those of the Lower Chagres will transport to the present mouth of the Chagres, the tributaries now entering the river on its left bank, the most important of which are the Obispo, the Arena, and the Trinidad. The Rio Grande will be deflected entirely to the right of the canal, and will enter the sea at La Boca. The total length of the deflections will be 64 kilometres. Some of them will be 40 metres wide and 3 deep; others, 30 metres wide and 5 deep. Erosion will increase these dimensions. Lying in valleys where feasible, the soil is alluvial, and easily excavated. It has occasionally happened that a subterranean stream has undermined the banks, and caused a break. The engineers claim that so far the repairs are effective, and I see no cause to disagree with them.

The following table shows the total excavation in both canal and derivations. The figures are those of the Canal Company, expressed in cubic metres:

SECTIONS.	CANAL.			DEFLECTIONS.		
	Original cube.	Cube excavated.	Cube remaining.	Original cube.	Cube excavated.	Cube remaining.
Colon	2,500,000	1,900,000	600,000	600,000	420,000	180,000
Gatun	6,300,000	5,300,000	1,000,000	3,000,000	2,600,000	400,000
Bohio	5,500,000	2,100,000	3,400,000	1,100,000	450,000	650,000
Tavernilla	6,000,000	500,000	5,500,000	1,200,000	100,000	1,100,000
San Pablo	4,000,000	1,200,000	2,800,000	900,000	90,000	810,000
Gorgona	4,500,000	1,600,000	2,900,000	850,000	260,000	590,000
Matachin	3,250,000	1,200,000	2,050,000	400,000	150,000	250,000
Obispo	10,000,000	3,100,000	6,900,000	900,000	90,000	810,000
Emperador	19,000,000	4,300,000	14,700,000	500,000	.....	500,000
Culebra	23,000,000	2,100,000	20,900,000	None.	.....	.....
Paraiso	7,000,000	1,800,000	5,200,000	240,000	180,000	60,000
Corozal	1,600,000	400,000	1,200,000	150,000	100,000	50,000
La Boca	2,500,000	1,900,000	600,000	100,000	80,000	20,000
Total	95,150,000	27,400,000	67,750,000	9,940,000	4,520,000	5,420,000

According to these statistics the total cube of canal and deflections was 105,090,000 cubic metres; the amount excavated is 31,920,000 cubic metres, leaving 73,170,000 to be removed. In other words, thirty per cent of the work is finished, and seventy per cent remains. The deflections are nearly half finished. The principal machine-shops are at Colon, Matachin, and Panama. These, with the hospitals and quarters for officials and laborers, if placed side by side, would cover an area of eighty-one acres. They are frame-buildings, picturesquely situated, with sills resting on masonry supports, and roofs of corrugated iron. They are clean, well-ventilated, and admirably suited to the climate of the Isthmus. The "cantines" are kept by Chinamen, who board the laborers at reasonable rates. The native huts are unhealthy; the vegetable matter of a thatched roof decays and becomes a harbor for insects. The present quarters are decidedly in the line of economy both as regards health and future expense and needs. I visited the Isthmus in 1881, when the country was a thickly-matted jungle, the only signs of habitation being a few huts at railway-stations. To-day thousands of acres are cleared, and such is the installation of the company that the canal seems to lie in a prosperous and populous district. In fact, the passenger from Matachin to Culebra is reminded rather of a single settlement than of several railway-stations.

At the time of my visit 10,640 workmen were employed by the contractors; with the 926 employés of the company, the total force was 11,566 men. The laborers are chiefly negroes from Jamaica or other islands, with a few from our Southern States, who have gone to Colon in coasting-vessels, and have been attracted by the wages of $1.50 per day in Colombian coin. About 300 Kroomen and as many

Chinese recently brought over, have shown themselves good workmen. Time contracts are unknown; Government officials in the islands discourage negro emigration to the Isthmus; and changes are arising constantly from sickness, dissipation, return to homes, or fear of revolution. Many leave through fear of climate, lack of guaranteed hospital attendance, and the exorbitant rates of the Isthmus.

On Saturday the laborers are paid. Sunday is spent in dissipation or pleasure, Monday in recuperation, and it is not till Tuesday that a full force is at work; hence the number of working-days in a month seldom exceeds twenty or twenty-two. Twenty thousand laborers are wanted; and as the West Indies do not supply them, the company is trying to solve the difficult question of labor in the populations of Western Africa and Southern China.

The main hospitals are at Colon and Panama, but physicians are assigned also to each section of the works. There is, too, a sanitarium on Taboga, an island fourteen miles from Panama. The entire medical staff consists of thirty physicians and fifty apothecaries. It must be increased and other hospitals provided, if additions be made to the force of laborers. The hospital service has been much criticised, and it has been asserted that contractors discharge the sick, who die for lack of medical attendance. During my stay of six weeks on the Isthmus I saw nothing to confirm such statement. The hospital records show a death-rate of seven per cent to January, 1887; but this does not include those who, on account of illness or disease contracted here, have left and died elsewhere.

In the original act of concession, Colombia agreed to surrender to the Canal Company a border 200 metres wide on each side of the canal, and 500,000 hectares (1,235,571 acres) of public lands as the work progresses. The first grant of 150,000 hectares, made when the Colombian Government conceded that one third of the total work necessary for the construction of the canal had been done, is situated near the Chiriqui Lagoon and along the Tuira River. Besides this, the company has bought 34,653 acres between Colon and Panama. On the 9th of October, 1886, the first grant was increased to 250,000 hectares, the Government conceding that one half of the necessary work had been finished. The company owns, therefore, 652,438 acres of land, besides the border of 200 metres on each side of the canal.

By this, however, neither the Government nor the company concede that one half of the necessary excavation has been made; but that the present excavation, plus the quarters for officials and workmen, the hospitals, and the plant of machinery, represents one half of the total work required to finish the canal. Undoubtedly, quarters and machinery are important factors of the total work, but they do not represent twenty per cent of it; the Government would be sufficiently liberal in conceding to-day that one third of the total work has been done.

In 1870 the traffic of the Suez Canal was represented by 486 ships of 435,911 tons, yielding a revenue of 5,159,327 francs; in 1885 it was 3,624 vessels, of 8,985,411 tons, and paying 62,207,439 francs. M. Levasseur, Member of the Institute, taking the statistics of 1876 as a basis, estimates that if the canal were open in 1889, the tonnage of vessels passing through it would be 7,250,000. M. Marteau, editor of the "Journal du Havre," places it at 9,000,000 tons. Both gentlemen disregard the markets of the Mediterranean and of India, and send the entire commerce of Western Europe through the Panama Canal during the first year of its existence. Presuming a tariff of fifteen francs per ton, the receipts from either estimate would not remunerate at the outset a capital exceeding $240,000,000, when expenses of administration and repair are deducted. On the 1st of last March the total sum realized from the company's loans was $179,771,190. As a new loan has since been raised, this sum must be wholly expended. It is evident that the final cost will exceed the sum warranted by the estimates.

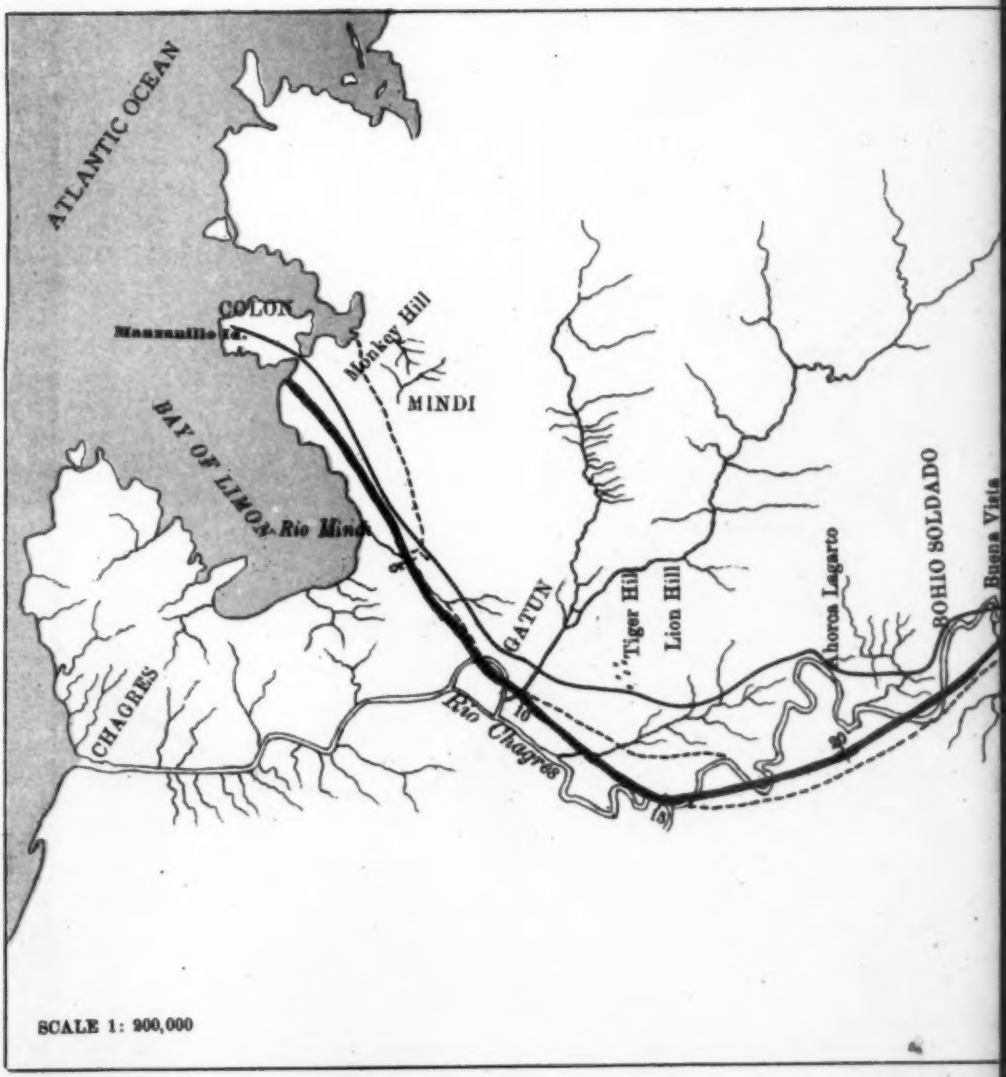
No exact estimate of the time and money required to finish the canal can be made, as much of the data needed is unknown. M. Charles de Lesseps said to me: "In two years the canal will be finished from Colon to kilometre forty-four, and from La Boca to Paraiso. As to the Culebra, I leave you to form your own conclusions. It is a great and difficult work."

It is evident that the rate of excavation in a work of such magnitude must be small until the plant is complete; it is equally true that more work can be done in a given time with a complete installation than with one of less size. Hence it is false reasoning to conclude that if 32,000,000 cubic metres are excavated in five years, it will require twelve years to extract the remaining 73,000,000. That such reasoning is absurd is shown by the cube of last year, which was 11,727,000 cubic metres. At this rate it would require about seven years to complete the canal. It is not probable that this rate will be exceeded materially for a year or more.

Keeping in mind the sum already expended, and the purposes to which it was applied, it is unreasonable to presume that the final cost of the canal will be less than 2,000,000,000 francs, or about $375,000,000. These figures are now acknowledged by the company; but owing to the great sacrifice at which the loans are obtained, the liabilities of the company will be nearly double this amount.

Any views concerning the completion of the canal by the present company must be conjectural; but if the present loan be expended with economy, the results will enhance the prospects of success.

At Colon there were many residents and foreigners not interested in the canal. The most bitter opponents of the enterprise were Americans and Englishmen, or former employés of the company who had been discharged or had a similar grievance. But from all sources there was a free admission that the company has both brains and energy,



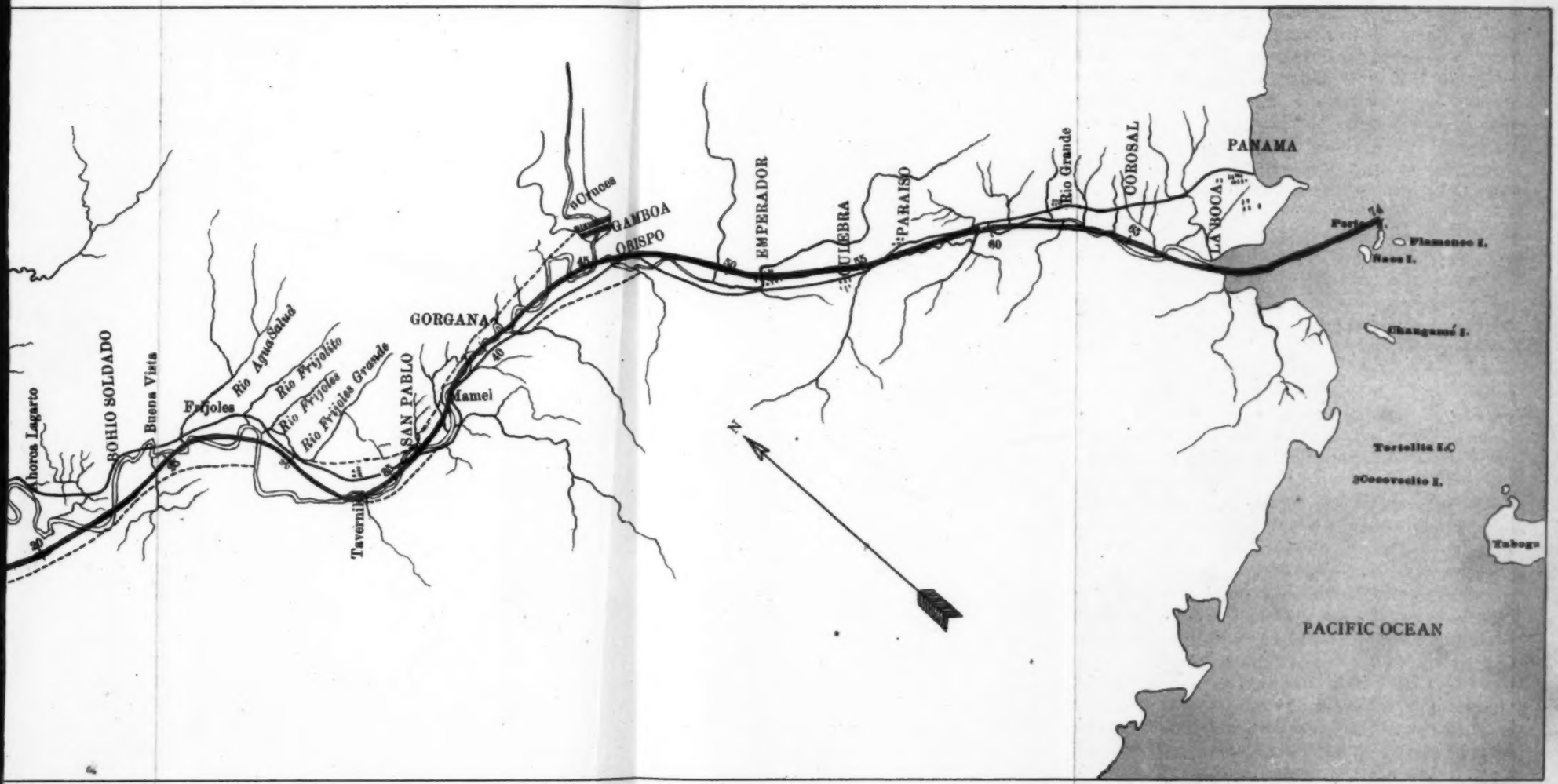
Dredged and now open to water.

Reserved for dredges.

Deflections.

PANAMA CANAL.

GENERAL PLAN



In course of preparation for dredges.

Earth removed by excavators.

Dimensions of Canal :

Width on bottom——22 metres.

Width at surface——40 "

Depth ——9 "

that the canal presents no insuperable obstacles, and that its completion is a question of time and money.

ADDENDA.—In a report dated September 1st, Señor Armero, agent of the Colombian Government, estimates the whole sum required to finish the canal at 3,012,495,400 francs, equal to $602,639,080. This fabulous sum he believes will be raised because so many millions are already sunk in the work, and half a million holders of stocks and bonds are interested, and the honor of France is at stake. But at the rate of progress so far attained the work can not be completed, nor can even the temporary canal, with locks, etc., now proposed by M. de Lesseps, be opened to traffic in 1889 or even in 1892, the year in which the concession terminates.

The proposed plan of M. de Lesseps is to excavate the 60 kilometres of lower elevations by present methods, and to form a lake of the 14 kilometres of central mass, to be reached on both the Pacific and the Atlantic sides by locks. By this means he proposes to finish the temporary canal by 1890 at a cost of 1,500,000,000 francs. The temporary canal completed, dredges will continue their work in the lake and gradually deepen the channel till a sea-level canal shall be formed from ocean to ocean.

THE ECONOMIC OUTLOOK—PRESENT AND PROSPECTIVE.

BY HON. DAVID A. WELLS.

ECONOMIC DISTURBANCE SERIES, No. VIII.

PART I.

THE predominant feeling induced by a review and consideration of the numerous and complex economic changes and disturbances that have occurred since 1873 (as has been detailed in the foregoing papers of this series), is undoubtedly, in the case of very many persons, discouraging and pessimistic. What many think but hesitate to say, finds forcible expression in the following extract from a letter addressed to the writer by a large-hearted, sympathetic man, who is at the same time one of the best known of American journalists and leaders of public opinion. After referring to his great interest in the general subject, he says:

> But what a deplorable and quite awful picture you suggest of the future! The wheel of progress is to be run over the whole human race and smash us all, or nearly all, to a monstrous flatness. I get up from the reading of the articles scared, and more satisfied than ever before that the true and wise course of every man is to get somewhere a piece of land, raise and make what he can for himself, and try thus to get out of the crushing process. It seems to me that what we call civilization is to degrade and incapacitate the mass of men and women; and how strange and incongruous a state it is. At the same time these masses of men are thrown out of their accustomed employments by the introduction or

perfection of machinery—at that very time the number of women and children employed in factories rapidly increases; an unprecedented cheapness of all necessaries of life is coincident with an intensification of the bitter struggle for bread and shelter. It is a new form of slavery which, it seems to me, projects itself into view—universal slavery—not patriarchal, but mercantile. I get yearly more tired of what we call civilization. It seems to me a preposterous fraud. It does not give us leisure; it does not enable us to be clean except at a monstrous cost; it affects us with horrible diseases—like diphtheria and typhoid fever—poisoning our water and the air we breathe; it fosters the vicious classes—the politicians and the liquor-sellers—so that these grow continually more formidable, and it compels mankind to a strife for bread, which makes us all meaner than God intended us to be. Do you really think the "game pays for the candle"?

A review of the causes of the recent economic disturbances in which sympathetic sentiments are allowed to predominate, is not, however, what is needed for estimating their present and future influence; but rather a review which will array and consider the facts and the conclusions which can be fairly deduced from them, apart, if possible, from the slightest humanitarian predisposition. The surgeon's probe that trembles in sympathy with the quivering flesh into which it penetrates, is not the instrumentality best adapted for making a correct diagnosis.

In attempting such a review the first point worthy of attention is, that with the exception of a change unprecedented in modern times—in the relative values of the precious metals—all that has occurred differs from the world's past experience simply in *degree* and not in *kind*. We have, therefore, no absolutely unknown factors to deal with; and if the record of the past is not as perfect as could be desired—for it is only within a comparatively recent period that those exact statistics which constitute the foundations and absolute essentials of all correct economic reasoning have been gathered—it is, nevertheless, sufficiently so to insure against the commission of any serious errors in forecasting the future, of what in respect to industry and society is clearly a process of evolution. This evolution exists in virtue of a law of constant acceleration of knowledge among men of the forces of Nature, and in acquiring a capacity to use them for increasing or supplementing human effort, for the purpose of increasing and cheapening the work of production and distribution. There is, furthermore, no reason for doubting that this evolution is to continue, although no one at any one time can foretell what are to be the next phases of development, or even so much as imagine the ultimate goal to which such progress tends. The ignorance, prejudice, and selfishness of man may operate in the future, as in the past and at present, in obstructing this progress; but to entirely arrest it, or even effect a brief retrogression, would seem to be utterly impossible.*

* Those persons whose business renders them most conversant with patents, are the ones most sanguine, that nothing is likely to occur to interrupt or even check, in the immediate future, the progress of invention and discovery.

The questions which naturally next suggest themselves, and in fact are being continually asked, are: Is mankind being made happier or better by this progress? or, on the contrary, is not its tendency, as Dr. Siemens, of Berlin, has expressed it, "to the destruction of all of our ideals and to coarse sensualism; to aggravate injustice in the distribution of wealth; diminish to individual laborers the opportunities for independent work, and thereby bring them into a more dependent position; and, finally, is not the supremacy of birth and the sword about to be superseded by the still more oppressive reign of inherited or acquired property?"

That many of the features of the situation are, when considered by themselves, disagreeable and even appalling, can not be denied. When one recalls, for example, through what seemingly weird power of genius, machinery has been summoned into existence—machinery which does not sleep, does not need rest, is not the recipient of wages; is most profitable when most unremittingly employed—and how no one agency has so stimulated its invention and use as the opposition of those whose toil it has supplemented or lightened—the first remedial idea of every employer whose labor is discontented being to devise and use a tool in place of a man;* and how in the place of being a bond-slave it seems to be passing beyond control and assuming the mastery; when one recalls all these incidents of progress, the following story of Eastern magic might be almost regarded in the light of a purposely obscured old-time prophecy. A certain man, having by great learning obtained knowledge of an incantation whereby he could compel inanimate objects to work for him, commanded a stick to bring him water. The stick at once obeyed. But when water sufficient for the man's necessities had been brought, and there was threatened danger of an oversupply, he desired the stick to stop working. Having, however, omitted to learn the words for revoking the incantation, the stick refused to obey. Thereupon, the magician in anger caught up

* The following is one striking illustration in proof of this statement: After the reaping-machine had been perfected to a high degree, and had come into general use in the great wheat-growing States of the Northwest, the farmer found himself for ten or fifteen days during the harvest period at the mercy of a set of men who made his necessity for binding the wheat concurrently with its reaping, their opportunity. They began their work in the southern section of the wheat-producing States, and moved northward with the progress of the harvesting; demanding and obtaining $2, $3, and even $4 and upward, per day, besides their board and lodging, for binding; making themselves, moreover, at times very disagreeable in the farmers' families, and materially reducing through their extravagant wages the profits of the crop. An urgent demand was thus created for a machine that would bind as well as reap; and after a time it came, and now wheat is bound as it is harvested, without the intervention of any manual labor. When the sheafs were first mechanically bound, iron wire was used as the binding material; but when a monopoly manufacturer, protected by patents and tariffs, charged what was regarded an undue price for wire, cheap and coarse twine was substituted; and latterly a machine has been invented and introduced, which binds with a wisp of the same straw that is being harvested.

an axe, and, with a view to diminish or destroy the power of the stick to perform work, chopped it into several pieces; whereupon, each piece immediately began to bring as much water as one had formerly done; and in the end not only the magician but the whole world was deluged and destroyed.

The proposition, that "all transitions in the life of society, even those to a better stage, are inevitably accompanied by human suffering," is undoubtedly correct. It is impossible, as an old-time writer (Sir James Stewart, 1767) has remarked, to even sweep a room without raising a dust and occasioning temporary discomfort. But those who are inclined to take discouraging and pessimistic views of recent economic movements, seem not only to forget this, but also to content themselves with looking mainly at the bad results of such movements, in place of the good and bad together. So it is not difficult to understand how a person like the Russian novelist Tolstoi, a man of genius, but whose life and writings show him to be eccentric almost to the verge of insanity, should, after familiarizing himself with peasant life in Russia, come to the conclusion "that the edifice of civil society, erected by the toil and energy of countless generations, is a crumbling ruin." But the trials and vicissitudes of life as Tolstoi finds them among the masses of Russia are the result of an original barbarism and savagery from which the composite races of that country have not yet been able to emancipate themselves; coupled with the existence of a typically despotic government, which throttles every movement for increased freedom in respect to both person and thought. But these are results for which the higher civilization of other countries is in nowise responsible and can not at present help, but the indirect influence of which will, without doubt, in time powerfully affect and even entirely change. No one, furthermore, can familiarize himself with life as it exists in the slums and tenement-houses of all great cities in countries of the highest civilization; or in sterile Newfoundland, where all nature is harsh and niggardly; or in sunny Mexico and the islands of the West Indies, where she is all bountiful and attractive, without finding much to sicken him with the aspects under which average humanity presents itself. But even here the evidence is absolutely conclusive that matters are not worse, but almost immeasurably better than formerly; and that the possibilities for melioration, through what may be termed the general drift of affairs, is, beyond all comparison, greater than at any former period.

The first and signal result of the recent remarkable changes in the conditions of production and distribution, which in turn have been so conducive of industrial and societary disturbances, has been to greatly increase the abundance and reduce the price of most useful and desirable commodities. If some may say, "What of that, so long as distribution is impeded and has not been correspondingly perfected?" it may be answered, that production and distribution in virtue of a

natural law are correlative or reciprocal. We produce to consume, and we consume to produce, and the one will not go on independently of the other; and although there may be, and actually is, and mainly through the influence of bad laws, more or less extensive mal-adjustment of these two great agencies, the tendency is, and by methods to be hereafter pointed out, for the two to come closer and closer into correspondence.

Next in order, it is important to recognize and keep clearly in view in reasoning upon this subject, what of good these same agencies, whose influence in respect to the future is now regarded by so many with alarm or suspicion, have already accomplished.

A hundred years ago the maintenance of the existing population of Great Britain, of the United States, and of all other highly-civilized countries, could not have been possible under the then imperfect and limited conditions of production and distribution. Malthus, who in 1798 was led by his investigations to the conclusion that the population of the world, and particularly of England, was rapidly pressing upon the limits of subsistence, and could not go on increasing because there would not be food for its support, was entirely right from his standpoint on the then existing economic conditions; * and no society at the present time, no matter how favorable may be its environments in respect to fertility of land, geniality of climate, and sparseness of population, is making any progress except through methods that in Malthus's day were practically unknown. The Malthusian theory is, moreover, completely exemplifying itself to-day in India, which is densely populated, destitute in great degree of roads, and of the knowledge and use of machinery. For here the conditions of peace established under British rule are proving so effective in removing the many obstacles to the growth of population that formerly existed, that its increase from year to year is pressing so rapidly on the means of subsistence, that periodical famines, over large areas, and accompanied with great destruction of life, are regarded as so inevitable that the creation of a national famine fund by the Government has been deemed necessary.†

* "Malthus made no prediction in the strict sense of the word. He had drawn out from experience that the human race tended to increase faster than the means of subsistence; its natural increase being in geometrical ratio, and the increase of its means of subsistence an arithmetical one; so that population had been kept down only in past times by war and famine, and by disease as the consequence of famine. He was bound to anticipate that a continuance of the process would expose the race once more to the operation of these natural checks, or to a descent of the masses in the scale of living, or to both of these evils. That the new experience has been different from the former one, and that owing to various causes the means of subsistence have increased faster than the population, even when increasing at a Malthusian rate, is no disproof surely of the teaching of Malthus. His statistical inquiries into the past remain as valuable as ever."—"*Some General Uses of Statistical Knowledge.*" Robert Giffen, *Royal Statistical Society of England, 1885.*

† The present condition of India constitutes one of the most curious and interesting

Illustrations confirmatory of the assertion that the food resources of half a century ago would be inadequate for the support of the existing population of the leading civilized countries are familiar, but the following are so striking as to warrant renewed presentation:

All the resources of the population of the United States, as they existed in 1880, would have been wholly inadequate to have sowed or harvested the present average annual corn or wheat crops of the country; and, even if these two results had been accomplished, the greater proportion of such a cereal product would have been of no value to the cultivator, and must have rotted on the ground for lack of any means of adequate distribution; the cost of the transportation of a ton of wheat, worth twenty-five dollars at a market, for a distance of a hundred and twenty miles over good roads, and with good teams and vehicles, entirely exhausting its initial value.

Forty years ago corn (maize) was shelled in the United States by scraping the ears against the sharp edge of a frying-pan or shovel, or

economic and social problems of the last quarter of the nineteenth century. While the general average of the population for the whole country is 184 to the square mile, there are districts in India in which a population, to be counted by tens of millions, averages from 300 to 400 to the square mile, and others in which a population, to be counted by some millions, rises to 800, and even 900, to the square mile. These latter probably constitute the most densely-populated districts of the world, the population of the most densely-peopled country of Europe—namely, Belgium—averaging 480 to the square mile. The total population of India is estimated at 250,000,000. Under the old-time system of native rulers, frequent wars, consequent on foreign invasions and internal race antagonisms, with accompanying famines and epidemic diseases, materially restricted the growth of population. But under the conditions of peace, with protection for life and property, which have been attendant in late years on British rule, the population of India is increasing so rapidly—nearly one per cent per annum—and so disproportionately to the amount of new and fertile soil that can be appropriated, as to leave but little margin, under existing methods of cultivation, for increasing the means of subsistence for the people. Much new soil has been put under cultivation during the last century of British rule, and a quarter of a million of square miles of cultivable waste yet remains to be occupied; but the fact that the national revenues from the taxation of land have not increased to any extent in recent years is regarded as proof that land cultivation is not increasing in proportion to the growth of population, and that the limits of agricultural production are approaching exhaustion. An annual increase of one per cent on the present population of India means at least 20,000,000 more people to feed in ten years, and upward of 40,000,000 in twenty years; and the problem to which the British Government in India has now before it, and to which it is devoting itself with great energy and intelligence, is, in what way, and by what means, can the character and habits of the people—especially in respect to their methods of agriculture—be so developed and changed that "their industry can become more efficient on practically the same soil?" Much has been already done in the way of increasing and cheapening, through roads, canals, and railroads, the means of transportation, and in promoting irrigation and education, and especially the use of new tools and methods for cultivating the soil. But so many are the obstacles, and so great is the moral inertia of the people, that, although remarkable progress has been made, the prospect seems to be that, "from decade to decade, larger and larger masses of the semi-pauperized, or wholly pauperized, will grow up in India, requiring state intervention to feed them, and threatening social and financial difficulties of the most dangerous character."

by using the cob of one ear to shell the corn from another. In this way about five bushels in ten hours could be shelled, and the laborer would have received about one fifth of the product. The six great corn States are Illinois, Indiana, Missouri, Iowa, Ohio, and Kansas. They produce more than one half the corn raised in the country. These States, by the census of 1880, had 2,056,770 persons engaged in agriculture, and it would have been necessary for this entire community to have sat astride of shovels and frying-pans for one hundred and ten days out of three hundred and sixty-five to have shelled their corn-crop for the year 1880 by the old processes.

In 1790, before the grain-"cradle" was invented, an able-bodied farm-laborer in Great Britain could with a sickle reap only about a quarter of an acre of wheat in a day; at the present time a man with two horses can cut, rake, and bind in a day the wheat-product of twenty acres.

Forty years ago a deficient harvest in any one of the countries of Europe entailed a vast amount of suffering and starvation on their population. To-day the deficiency of any local crop of wheat is comparatively of little consequence, for the prices of cereals in every country readily accessible by railroad and steamships is now regulated, not by any local conditions, but by the combined production and consumption of the world; and the day of famines for the people of all such countries has passed forever.* The extent to which all local advantages in respect to the supply and prices of food have been equalized in recent years through the railway service of the United States, is demonstrated by the fact that a full year's supply of meat and bread for an adult person can now be moved from the points of their most abundant and cheapest production, a thousand miles, for a cost not in excess of the single day's wages of an average American mechanic or artisan.

The same conditions that one hundred, or even fifty, years ago

* It is not a little difficult to realize that the causes which were operative to occasion famines a hundred years ago in Western Europe, and which have now apparently passed away forever, are still operative over large portions of the Eastern world. The details of the last great famine in China, which occurred a few years ago, indicate that over five million people died of starvation in the famine district, while in other portions of the Empire the crops were more abundant than usual. The trouble was that there were no means of transporting the food to where it was needed. The distance of the famine area to the port of Tientsin, a point to which food could be and was readily transported by water, was not over 200 miles; and yet when the foreign residents of Shanghai sent through the missionaries an important contribution of relief, it required fifteen days, with the employment of all the men, beasts, and vehicles that could be procured, to effect the transportation of the contribution in question over this comparatively short distance. Relief to any appreciable extent to the starving people from the outside and prosperous districts was, therefore, impracticable. Contrast these experiences with the statement that when Chicago burned up in 1871 a train loaded with relief contributions from the city of New York, over the Erie Railroad, reached its destination in twenty-one hours after the time of its departure.

limited the supply of food, and made it confessedly inadequate to meet the demands of a population increasing in a greatly disproportionate ratio, also limited the opportunities for employment to such increasing numbers apart from agriculture. Nearly and probably full one half of all those who now earn their living in industrial pursuits, do so in occupations that not only had no existence, but which had not even been conceived of a hundred years ago. The business of railroad construction, equipment, and operation, which now furnishes employment, directly or indirectly, to about one tenth of all the population of the United States engaged in gainful occupations, was wholly unknown in 1830. Apart from domestic or farm service little opportunity existed for women to earn a livelihood by labor at the commencement of the present century.

The existence of the present populations of Europe and the United States—nay, more, the continuance and progress of civilization itself—has therefore been made possible solely through the invention and use of the same labor-saving machinery, which not a few are inclined to regard as likely to work permanent injury to the masses in the future. It is still easy to avoid all trouble arising out of the use of labor-saving machinery by going to the numerous countries—many of which are rich in the bounties of Nature—which do not possess it. But these are the very countries to which no person of average intelligence desires to go.

Restless and progressive humanity generally believes also, that the continued betterment of the race is largely conditioned on the extension of free government based on popular representation and constitutional safeguards; and also on the successful continuation of the experiment under such conditions which was entered upon by the people of the United States just a hundred years ago. But the Government of the United States, under its existing Constitution, has been made possible only through the progress which man has made in recent years in his knowledge and control of the forces of Nature. Without the perfected railroad and telegraph systems the war for the maintenance of the Federal Union under the existing Constitution could not probably have been prosecuted to a successful conclusion; and even if no domestic strife had intervened, it is more than doubtful whether a federation of numerous States, sovereign in many particulars—floating down the stream of time like an elongated series of separate rafts, linked together—could have been indefinitely perpetuated, when the time necessary to overcome the distance between its extremities for the mere transmission of intelligence amounted to from twenty to thirty days.*

In every highly-civilized country, where accurate investigations have been instituted, the consumption of all the substantial articles of

* When the battle of New Orleans was fought in 1815, more than twenty-two days elapsed before the Government at Washington received any information of its occurrence.

food has, within recent years, been largely and progressively increasing; and as the consumption of rich and well-to-do people in such countries remains almost stationary, inasmuch as they have always been able to have all they desired of such articles, it is reasonable to infer that this result has been mainly due to the annually increasing ability of the masses to consume. In Great Britain, where this matter has been more thoroughly investigated than in any other country, the facts revealed (as will be presently shown) are most extraordinary. In the case of the population of Paris, M. Leroy-Beaulieu also reports a wonderful increase in the consumption of food-products since 1866, and states that, if the ravages of the phylloxera (vine pest) could be checked, and the price of wine reduced, the cost of living for the whole of France would be less than it has ever been during the last half-century.

Furthermore, not only has the supply of food increased, but the variety of food available to the masses has become greater. Nearly all tropical fruits that will bear transportation have become as cheap in non-tropical countries as the domestic fruits of the latter, and even cheaper; and the increased consumption thus induced has built up new and extensive branches of business, and brought prosperity to the people of many localities that heretofore have had no markets for any products of their industry.

An acre of the sea, cultivated by comparatively recently-discovered methods, is said to be capable of yielding as much food as any acre of fertile dry land; but thirty or forty years ago, fish in its most acceptable form—namely, fresh—was only available to consumers living in close proximity to the ocean. Now, fish caught on the waters of the North Pacific, and transported more than 2,000 miles, are daily supplied fresh to the markets of the Atlantic slope of the United States, and sea-products of the coast of the latter, transported 2,000 miles, are regularly furnished in a fresh condition to British markets.

One point of immense and novel importance in helping to a conclusion as to whether the race under the conditions of high civilization is tending toward increased comfort and prosperity, or toward greater poverty and degradation, is to be found in the fact which recent investigators have determined, namely: that in the United States the daily wages paid, or the daily earning capacity of a healthy adult worker, in even the most poorly remunerated employments, is more than sufficient, if properly expended, to far remove the individual recipient from anything like absolute want, suffering, or starvation. Thus, in the case of fifty-nine adult female operatives in a well-managed cotton-mill in Maryland, the per-capita cost of subsistence, with a bill of fare embracing meats, all ordinary groceries and vegetables, milk, eggs, butter, fish, and fruit, has been found to be not in excess of twenty cents per day, including the cost of the preparation of the food and its serving. In Massachusetts, where the results were derived from the

six months' boarding of seventeen men and eight women (three servants), the men being engaged in arduous mechanical employments, and consuming comparatively large quantities of meat, the daily cost of the subsistance of each individual was twenty-eight cents per day. In the jails of Massachusetts the average daily cost of the food of the prisoners and of the employés of the prisons for the year 1883—bread of the best quality, good meats, vegetables, tea, rye-coffee, sugar, etc., being furnished liberally—was a trifle over fifteen cents per day for each person.*

In one of the best conducted almshouses of Connecticut, the condition of which has been carefully investigated by the writer, the sum of $7,000 per annum, exclusive of interest on the plant and extraordinary repairs, is believed to be amply sufficient to maintain an average of sixty-five inmates, mainly adults, in a building of modern construction, scrupulously clean, thoroughly warmed and ventilated, with an abundance of good and varied food, clothing and medical attendance, or at an average daily expenditure of about thirty cents per capita.

The evidence, therefore, is conclusive, "that an ample and varied supply of attractive and nutritious food can be furnished in the eastern portions of the United States—and probably in Great Britain also—at a cost not exceeding twenty cents per day, and for a less sum in the western sections of the country, provided that it is judiciously purchased and economically served"; and the legitimate inference from these results is, that the problem of greatest importance to be solved in the United States and in Great Britain, in the work of ameliorating the condition of the honest and industrious poor is (as Mr. Atkinson has expressed it), to find out how to furnish them with ample and excellent food as cheaply as it is supplied to the inmates of our prisons and almshouses.†

The facts in regard to the general increase in the deposits of sav-

* These results are due to the laborious and careful investigations of Mr. Edward Atkinson, of Massachusetts, and were first published in 1884, under the title of "The Distribution of Products." Together with the results of similar investigations conducted by Mr. Robert Giffen, of England, they rank among the most important and valuable contributions ever made to economic and social science.

† The following results of one of the first and most recent efforts to practically carry out this idea are especially worthy of recording in connection with this discussion, and in the highest degree encouraging: Early in the fall of 1887 a number of public-spirited, philanthropic ladies in the city of New York, in charge of a large working-girl's club, determined to try the experiment of founding and managing a working-girl's boarding-house, with a view of ascertaining at what cost a good and varied subsistence and good lodging could be furnished to young women dependent upon their own exertions in a great city for a livelihood, and to whom, by reason of comparatively small incomes, the practice of rigid economy was imperative. For this purpose an attractive and suitable house on a good street was taken at an annual rent of $1,000, and a matron engaged who was thoroughly conversant with the art of advantageously buying and preparing and serving food. As was to be expected, some little time was required to put the experiment

ings-banks, and the decrease in pauperism are also entitled to the highest consideration in this discussion. In the United States the aggregate savings-bank deposits increased from $849,581,000 in 1873, to $2,152,932,000 in 1886, an increase of over 150 per cent in thirteen years, while the increase in the population of the country during that same time was probably not in excess of 30 per cent. The increase in the deposits of the savings-banks of all other countries, for which data are accessible, show the same law of rapid increase, though not in so large a progressive ratio as in the United States. Thus, in Great Britain the increase between 1875 and 1885 as regards deposits was 40 per cent, and in the number of depositors over 50 per cent,* while the increase in population during the same period was about 10 per cent. Switzerland and Sweden and Norway lead all the nations of Europe in the ratio of savings-deposits to the population—the increase, comparing 1860 with 1881, having been from the ratio of 4·2 to 35·5 in the former, and in the case of the latter, from 6·8 to 18·1. In Prussia, where the savings-banks are used almost exclusively by the poorer classes, the deposits for 1886 showed an increase of 876,000,000 marks over the year 1878. The percentage increase in deposits and depositors in France and Italy in recent years has also been large, and far in excess of any percentage increase in their population. The aggregate savings-deposits in various institutions and societies for the Continent of Europe, in 1885, was estimated at £338,000,000; or, including Great Britain, £538,000,000 ($2,690,000,000).

There are no statistics of national pauperism in the United States, and general conclusions are based mainly on the returns made in the eight States of New York, Pennsylvania, Ohio, Illinois, Massachusetts, Wisconsin, and Michigan. A report made by the standing com-

in full operation, and therefore the full details of the results of but one month (November, 1887), can be here furnished.

For this month the family consisted of twenty-one adult persons (females), including matron and servants; and the entire disbursements for all running expenses, except for fuel and rent, were $236.41, which were itemized as follows: food, $151.19; gas and oil, $8.83; ice, $1.30; incidentals, $9.54; furnishing, $9.05; salary of matron, $20.00; wages, $36.50. The average expense per individual per week was $2.81⅞. The average expenditure for food for each individual per week was $1.74; per day 24 cents. The sum of $276.30 was received for board, leaving a balance applicable for fuel and rent, for the month, of $49.71. The persons composing the family were not factory-hands, but stenographers, milliners, type-writers, and a few art students. The food furnished was not what would be properly called "cheap," but every way excellent; and the table is believed to far excel what will ordinarily command a charge of from $8 to $10 per week. As might be inferred, the larger rooms of the house were required to accommodate more than one person, but there was no crowding.

* The amount of deposits in the British Savings-Bank for 1886 was £98,000,000 ($490,000,000). But besides the savings-banks, there are in Great Britain a number of institutions for the promotion of thrift, which have no exact counterpart in the United States, and which hold also large amounts of the savings of the people, as railway savings-banks, incorporated provident building societies (with £50,000,000 of funds in 1885), friendly societies, etc., and in all of which the deposits are rapidly increasing.

mittee of the various State boards of charities to the National Conference of Charities in 1887 was, that "except for the insane, who are everywhere constantly accumulating beyond their due ratio to the whole population, there has never been for a period of five years any increase in the proportion of paupers to the population; while for longer periods there has generally been a decrease in the number of the poor as compared with the whole population"; and this, too, notwithstanding the very great obstacles which stand in the way of all public and private effort for the checking of pauperism in a country like the United States, "which annually receives such armies of poor from European countries, and at home permits intemperance to breed so much of pauperism, especially in cities."

In England, where the population, between 1875 and 1885, increased in a larger proportion than in any previous decade, there was no increase, but a very steady decrease of pauperism; or, from an annual average number of 952,000, or 4·2 per cent of the whole population in 1870–'77, to 787,000, or 3 per cent of the population for 1880–'84. For Scotland, the corresponding figures are much the same; although the Scotch administration of the poor is totally independent of that of the English. In short, there is no evidence that pauperism is increasing in England and Scotland with their recent marked increase in population, or that the people are less fully employed than formerly; but the evidence is all to the contrary. In Ireland, the experience has been different. "Here, there has been an increase in pauperism, accompanied by a decline in population," the number of paupers in receipt of relief, on the 1st of January, 1887, being returned as 113,241, as compared with 106,717 in 1883.* Comparing 1880 with 1850 the decline of pauperism in the United Kingdom was about 40 per cent.

Prussia, with a marked increase in population, returned a decrease in the number of paupers receiving relief from cities and towns from 3·87 per cent of the whole number in 1884, to 3·65 per cent in 1885.

Crime in Great Britain is diminishing. The same is reported of Italy. In the United States, while crime has diminished in a few States, for the whole country it has, within recent years, greatly increased. This is to be attributed, in the Northern States, mainly to the great foreign immigration, and, in the Southern, to the emancipation of the negroes.

Finally, an absolute demonstration that the progress of mankind, in countries where the new economic conditions have been most influential in producing those disturbances and transitions in industry and society which to many seem fraught with disaster, has been for the better and not for the worse, is to be found in the marked prolongation of human life, or decline in the average death-rate, which

* "The Material Progress of Great Britain"; address before the Economic Section of the British Association, 1887, by Robert Giffen.

has occurred within comparatively recent years in these same countries. Thus, the average annual death-rate in England and Wales, during the period from 1838 to 1875, was 22·3 per thousand. From 1876 to 1880, it was 20·8. But, for the six years from 1880 to 1887, the average has not exceeded 19·3; which means that about 500,000 persons in England and Wales were alive at the close of the year 1886 who would have been dead if the rate of mortality which prevailed between 1838 and 1875 had been maintained.* The average death-rate for the whole United States, for the census-year 1880, was between 17 and 18 per 1,000; which is believed to be a less mean rate than that of any European country except Sweden.

The results of the most recent and elaborate investigations on this subject, communicated, with data, by M. Vachee, to the "Bulletin de l'Institute International de Statistique," Rome, 1887, are, that the mortality of Europe has diminished from 25 to 33 per cent, and that the mean duration of life has increased from seven to twelve years, since the beginning of this century. This estimate of the rate of improvement for all Europe is higher than the English data would alone warrant, but may be correct. At the same time it is well recognized, that through the absence of reliable data it is impossible to speak *with certainty* as to the decrease in mortality, or as to the expectation of life in any country, except in respect to the last forty or fifty years.

Now, while improved sanitary knowledge and regulations have contributed to this result, it has been mainly due to the increase in the abundance and cheapness of food products; which in turn are almost wholly attributable to recent improvements in the methods of production and distribution. But whatever may have been the causes of these changes, they could not have occurred without an increase of vitality among the masses.

Again, if civilization is responsible for many new diseases, civilization should be credited with having stamped out, or greatly mitigated not a few that a century ago were extremely formidable. Plague and leprosy have practically long disappeared from countries of high civilization. For the five years from 1795 to 1800 the average annual number of deaths from small-pox in the city of London was 10,180; but for the five years from 1875 to 1880 it was only 1,408. Typhus and typhoid fevers are now known to be capable of prevention, and cholera and yellow fever of complete territorial restriction. Typhus fever, once the scourge of London, and especially of its prisons, is said to have now entirely disappeared from that city. No living physician has seen malignant syphilis as described in 1786 by the eminent English surgeon, John Hunter. Anæsthetics have removed the pain attendant upon surgical operations; and the use of antiseptics has re-

* It is also to be noted that by far the larger proportion of the increased duration of human life in England is lived at useful ages, and not at the dependent ages of either childhood or old age.

duced the mortality contingent upon the same in the larger hospitals; or, taking the experience of Germany as the basis of comparison, from 41·6 in 1868, to 4·35 per cent in 1880.

Dealers in ready-made clothing in the United States assert that they have been obliged to adopt a larger scale of sizes, in width as well as in length, to meet the demands of the average American man, than were required ten years ago; and that in the case of clothing manufactured for the special supply of the whole population of the southern sections of the country, this increase in size since the war, attributable almost entirely to the increased physical activity of the average individual, has been fully one inch around the chest and waist. Varieties of coarse clothing, as the brogan shoe and cotton drills, which before the war were sold in immense quantities in this same section of the country, have now almost passed out of demand, and been superseded by better and more expensive products. The American is, therefore, apparently gaining in size and weight, which could not have happened had there been anything like retrogression, or progress toward poverty on the part of the masses.

But the contribution of greatest value that could be made to the discussion of this subject, would be to spread before us an exhibit of the exact results of the experience of a country and a people, where under average, or not too favorable conditions, the recent changes in industrial and social life, consequent upon the new methods of production and distribution, have operated most influentially. Such an exact exhibit can not be made; but the experience of Great Britain, where economic data have been gathered and recorded during the last fifty years with an exactness and completeness not approached in any other country, furnishes a most gratifying and instructive approximation. To the record of this experience, attention is next requested.

During the last twenty-five or thirty years, the aggregate wealth of Great Britain, as also that of the United States and France, has increased in an extraordinary degree. In Great Britain the increase from 1843 to 1885 in the amount of property assessable to the income-tax is believed to have been 140 per cent, and from 1855 to 1885 about 100 per cent. The estimate of the total income of the country for 1886 was £1,270,000,000; and of its aggregate wealth, about £9,000,000,000, or $45,000,000,000. Have now the working-classes of Great Britain gained in proportion with others in this enormous development of material wealth? Thanks to the labors of such men as the late Dudley Baxter, Leon Levi, David Chadwick, and Robert Giffen, this question can be answered (comparatively speaking for the first time) with undoubted accuracy.

Fifty years ago, one third of the working masses of the United Kingdom were agricultural laborers; at present less than one eighth of the whole number are so employed. Fifty years ago the artisans represented about one third of the whole population; to-day they

represent three fourths. This change in the composition of the masses of itself implies improvement, even if there had been no increase in the wages of the different classes. But, during this same period, the "money" wages of all classes of labor in Great Britain have advanced about 100 per cent, while the purchasing power of the wages in respect to most commodities, especially in recent years, has been also very great. Among the few things that have not declined, house-rent is the most notable, a fact noticed equally in Great Britain and France, although in both countries the increase in the number of inhabited houses is very large; the increase in the item of houses in the income-tax assessments of the United Kingdom between 1875 and 1885 having been about 36 per cent.* But high rents, in the face of considerable building, are in themselves proof that other things are cheap, and that the competition for comfortable dwellings is great.

The Government of Great Britain keeps and publishes an annual record of the quantities of the principal articles imported, or subject to an excise (internal revenue) tax, which are retained for home consumption per head, by the total population of the kingdom. From these records the following table has been compiled. From a humanitarian point of view, it is one of the most wonderful things in the history of the latter half of the nineteenth century:

Per-capita consumption of different commodities (imported or subject to excise taxes) by the population of Great Britain.

ARTICLES.	1840.	1886.	ARTICLES.	1840.	1886.
Bacon and hams ..Lbs.	0·01	11·95	Raw sugar .....Lbs.	15·20	47·21
Butter..... "	1·05	7·17	Refined sugar..... "	None.	18·75
Cheese ..... "	0·92	5·14	Tea..... "	1·22	4·87
Currants and raisins "	1·45	4·02	Tobacco ..... "	0·86	1·42
Eggs .....No.	3·63	28·12	Wine .....Gals.	0·25	0·36
Rice.....Lbs.	0·90	10·75	Spirits (foreign) .. "	0·14	0·24
Cocoa ..... "	0·08	0·41	Spirits (British) .. "	0·83	0·73
Coffee..... "	1·08	0·86	Malt .....Bush.	1·59	1·64*
Wheat and wheat flour, Lbs.....	42·47	185·76	Beer (1881).....Gals.	27·78	26·61

* 1879.

During all the period of years covered by the statistics of this table, the purchasing power of the British people in respect to the necessities and luxuries of life has therefore been progressively increasing, and has been especially rapid since 1873–'76. Converting this increase in the purchasing power of wages into terms of money, the British workman can now purchase an amount of the necessaries of life for 28*s.* 5*d.*, which in 1839 would have cost him 34*s.* 0½*d.*† But this statement falls very far short of the advantages that have accrued

* The value of the new houses built in Great Britain since 1840 has been estimated at double the value of the British national debt.

† David Chadwick. British Association, 1887.

to him; for wages in Great Britain, as before stated, are fully 100 per cent higher at the present time than they were in 1839.

The impression probably prevails very generally in all countries that the capitalist classes are continually getting richer and richer, while the masses remain poor, or become poorer. But in Great Britian, where alone of all countries the material (i. e., through long-continued and systematized returns of incomes and estates [probate] for taxation) exists for scientific inquiry, the results of investigation demonstrate that this is not the case.

In the case of estates, the number subjected to legacy and succession duties within the last fifty years has increased in a ratio double that of population, but the average amount of property per estate has not sensibly augmented. If, therefore, wealth among the capitalist classes has greatly increased, as it has, there are more owners of it than ever before; or, in other words, wealth, to a certain extent, is more diffused than it was. Of the whole number of estates that were assessed for probate duty in Great Britain in 1886, 77·5 per cent were for estates representing property under £1,000 ($5,000).

In the matter of national income, a study of its increase and apportionment among the different classes in Great Britain has led to the following conclusions: Since 1843, when the income-tax figures begin, the increase in taxable income is believed to have been £755,000,000. Of this amount, the *income* from the capitalist classes increased about 100 per cent, or from £190,000,000 to £400,000,000. But, at the same time, the number of the capitalist classes increased so largely that the average amount of capital possessed among them per head increased only 15 per cent, although the increase in capital itself was in excess of 150 per cent. In the case of the "upper" and "middle" classes, the income from their "working" increased from £154,000,000 to £320,000,000, or about 100 per cent; while, in the case of the masses (i. e., the manual-labor classes), which have increased in population only 30 per cent since 1843, the increase of their incomes has gone up from £171,000,000 to £550,000,000, or over 200 per cent. Between 1877 and 1886 the number of assessments in Great Britain for incomes between £150 ($750) and £1,000 ($5,000) increased 19·26 per cent, while the number of assessments for incomes of £1,000 and upward decreased 2·4 per cent.* What has happened to all that large class

* The following table shows how wealth is distributed in the different classes of income-tax payers in Great Britain under Schedule D, which comprises incomes from profits on trades and employments:

"In 1877 the number of assessments of incomes from £150 to £500 was 285,754, and in 1886 it was 347,031, showing an increase of 21·4 per cent; of incomes between £500 and £1,000, the numbers were, in 1877, 32,085, and in 1886, 32,033, no increase at all; of incomes between £1,000 and £5,000, the numbers were, in 1877, 19,726, and in 1886, 19,250, a decrease of 2·4 per cent; and of the incomes over £5,000, the numbers were, in 1877, 3,122, and in 1886, 3,048, a decrease of 2·3 per cent. It results that from these figures the increase of the income-tax during times of depression and during ordinary

whose annual income does not reach the taxable limit (£150) is sufficiently indicated by the fact that while population increases pauperism diminishes.

Thus, in the United Kingdom, during the last fifty years, the general result of all industrial and societary movement, according to Mr. Giffen, has been that "the rich have become more numerous, but not richer individually; the 'poor' are, to some smaller extent, fewer; and those who remain 'poor' are, individually, twice as well off on the average as they were fifty years ago. The poor have thus had almost all the benefit of the great material advance of the last fifty years."

The following further citations from the record of the recent economic experiences of Great Britain are also strongly confirmatory of the above conclusions:

The amount of life insurance in the United Kingdom exceeds that of any other country; and the record here is a very rapid increase in the number of policies issued, but a large decrease in the average amount of the policies; the meaning of which clearly is that a larger number of people are not only continually becoming provident, but able to insure themselves for small amounts.

The changes in the relations of crime and of educational facilities during the last fifty years of the history of the British people, which have occurred and are still in progress, are in the highest degree encouraging. In 1839 the number of criminal offenders committed for trial was 54,000; in England, alone, 24,000. Now the corresponding figures (1886) were, United Kingdom, 19,446; England, 13,974. In 1840 one person for every 500 of the population of the British Islands was a convict; in 1885 the proportion was as one to every 4,100.

As late as 1842 there was no national school system in England, and there were towns with populations in excess of 100,000 in which there was not a single public day-school and not a single medical charity. In 1886 the number of attendants upon schools in the United Kingdom was reported at 5,250,000. In the same year the number in attendance upon schools, for the support of which grants of money are made by Parliament (and which correspond to the public schools of the United States) was 3,915,315, an increase over the preceding year of 85,335. The amount of such Parliamentary grants for 1886 was £3,945,576 ($19,728,830).

The change which has taken place in the relations of the Government of Great Britain to the national life of its people is also very remarkable. Thus at the commencement of the present century the British Government annually appropriated and spent about one third

times, during the times which we have been going through and which have not been times of great prosperity, there has been a most satisfactory increase in the incomes below £500, while no similar increase is seen in the incomes between £500 and £1,000, and upward."—Mr. Goschen, "*On the Distribution of Wealth*," *Royal Statistical Society of England, 1887.*

of the national income; now it expends annually about one twelfth. But for this greatly diminished expenditure the masses of the people now receive an immensely greater return than ever before; in the shape of increased postal and educational facilities, safer navigation, greater expenditures for the maintenance of the public health and public security, greater effort for preventing abuses of labor, etc.

The general conclusion from all these facts, as Mr. Giffen has expressed it, is that what "has happened to the working-classes in Great Britain during the last fifty years, is not so much what may properly be called an improvement, as a revolution of the most remarkable description." And this progress for the better has not been restricted to Great Britain, but has been simultaneously participated in to a greater or less extent by most, if not all, other countries claiming to be civilized. So far as similar investigations have been instituted in the United States, the results are even more favorable than in Great Britain. If they have not been equally favorable in other than these two countries, we have a right to infer that it has been, because the people of the former have not only started in their career of progress from a lower level of civilization and race basis than the latter, but have had more of disadvantages—natural and artificial—than the people of either Great Britain or the United States. The average earnings per head of the people of countries founded by the Anglo-Saxon race are confessedly larger than those of all other countries.*

But some may say; this is all very interesting and not to be disputed. But how does it help us to understand better and solve the industrial and social problems of to-day, when the cry of discontent on the part of the masses is certainly louder, and the inequality of condition, want, and suffering is *claimed* to be greater than ever before? In this way.

The record of progress in Great Britain above described is indisputably a record that has been made under circumstances that, if not wholly discouraging, were certainly unfavorable. It is the record of a country densely populated and of limited area, with the ownership, or free use of land, restricted to the comparatively few; with (until recent years) the largest national debt known in history; with a heavy burden of taxation apportioned on consumption rather than on accumulated property, and the reduction of which, a participation in constant wars and enormous military and naval expenditures has always obstructed or prevented; with a burden of pauperism at the outset, and, indeed, for the first half of the period under con-

* A recent British authority (Sir Richard Temple) makes the highest average earnings per head in any country at the present time to be in Australia, namely, £41 4s. Next in order, he places the United Kingdom, with an average per-capita earning capacity of £35 4s.; then the United States, with an average capacity of £27 4s.; and next, Canada, with an average of £26 18s. For the Continent of Europe the average is estimated at £18 1s.

sideration, which almost threatened the whole fabric of society; and, finally, with a long-continued indisposition on the part of the governing classes to make any concessions looking to the betterment of the masses, except under the pressure of influences which they had little or no share in creating. And yet, without any "violent specifics," or radical societary changes, and apart from any force of statute law, except so far as statute law has been an instrumentality for making previously-existing changes in public sentiment effective; but rather through the steady working of economic laws under continually increasing industrial and commercial freedom, the working masses of Great Britain, "in place of being a dependent class, without future and without hope, have come into a position from which they may reasonably expect to advance to any degree of comfort and civilization."

Now, with humanity occupying a higher vantage ground in every respect than ever before; with a remarkable increase in recent years in its knowledge and control of the forces of Nature—the direct and constant outcome of which is to increase the abundance of all useful and desirable commodities in a greater degree than the world has ever before experienced, and to mitigate the asperities and diminish the hours of toil—is it reasonable to expect that further progress in this direction is to be arrested? Is the present generation to be less successful in solving the difficult social problems that confront it than were a former generation in solving like problems which for their time were more difficult and embarrassing? If the answer is in the negative, then there is certainly small basis for pessimistic views respecting the effect of the recent industrial and social transitions in the future.

But, in view of these conclusions, what are the reasons for the almost universal discontent of labor?

THE MOON AND THE WEATHER.

By JOHN WESTWOOD OLIVER.

THE persistent survival of weather-lore in these days of intellectual emancipation is not at all remarkable when we consider the extent to which the vulgar sayings embody real truths. A few years ago Messrs. Abercromby and Marriott embarked on an extremely interesting inquiry with a view to determine, by actual comparison, how far the popular proverbs express relations, or sequences, which the results of meteorological science show to be real. The investigation proved that something like a hundred of the more popular sayings are, under ordinary conditions, trustworthy. Such being the case, we need not be surprised that simple country folk prefer familiar couplets to all the "isobars," "cyclones," and "synchronous charts," in the world.

If "hills clear, rain near," means the same as "the presence of a wedge-shaped area of high pressure, accompanied by great atmospheric visibility, is likely to be followed by the advance of a disturbance with rain and southerly winds," which for all practical purposes it does, the preference is justified on the mere ground of breath economy. The thirty-one words demanded by science stand no chance against four.

But it is unfortunate that, along with the limited number of folk-sayings founded on truth, there has survived a very large number founded on the grossest error. These latter have borrowed credence and respect from the proved credibility of the others, and apparently they are all destined to sink or swim together. Hammer as we will at certain favorite proverbs which we know to be based upon error, it is all in vain. The reverence for tradition is too much for us. And of all the superstitions, pure and simple, which defy our attempts at destruction, the most invulnerable are those ascribing certain effects to the influence of the moon. Few of the counties in England, Scotland, and Ireland but have their own peculiar observances referring to the supposed lunar influence upon diseases, destiny, etc. To merely enumerate these would require a small volume. Any who may care to see some specimens should consult a curious collection (but far from an exhaustive one) published last year by the Rev. Timothy Harley, under the title "Moon Lore." And of equal vitality with the other moon-myths is the idea of lunar influence upon the weather. There is this important difference, however, that while the attribution of supernatural powers to the moon is palpably and admittedly absurd, the idea of her influence on the weather is not founded on anything physically impossible, and has the sanction of striking analogy in the accepted doctrine of the tides. How much importance was attached to the inquiry, regarded as a true scientific investigation, in the earlier half of the century, and up even to very recent years, may be seen by consulting a meteorological bibliography. The constant succession of papers in English, French, and German, by accredited scientific men, and contributed to respectable scientific societies and periodicals, dealing with the lunar weather theory in all its aspects, shows this to have been long considered one of the most important problems of meteorology.

The doctrine of the survival of the fittest would not seem to be applicable to the case of wise saws. The criterion of fitness we may take to be the reliableness of the saw, and, as we have just seen, they survive without the slightest reference to that characteristic. Nevertheless, one is loath to believe that formulated nonsense can have found credence for ages unless there is a larger admixture of truth in it than is readily apparent by the light of our present knowledge. Popular error has been described as the perception of half the truth, or of one side of a truth. Were this invariably so, it would afford a profitable

employment to dissect popular errors with a view to discovering the half-truth, since we might be able to find its complement somewhere, and materially enrich the world. But that is not the sense I intend to convey. Nearly all weather sayings are of the nature of predictions. They describe a certain appearance of phenomenon, and then go on to say what other appearance or phenomenon may be expected to follow it. We have here a sequence of events; the ground of the saying (if it has any ground at all) is the invariability of the sequence. Now it is difficult to imagine such sequences being invented without any reference to the observed fact, and it is still more difficult to imagine them obtaining currency—not local currency merely, but sometimes universal currency—unless a certain number of observed instances have borne them out. Of course, by the laws of chances any sequence within the range of probability is bound to happen sometimes, but a sequence of weather phenomena is liable to variation in so many different directions that the purely chance happenings of any specified sequence are not numerous relatively to the blanks. I am disposed to assume, therefore, that all weather proverbs of this nature are founded upon one observed instance; and that, although many are only based upon the accidental recurrence of the sequence (and are consequently worthless), many also are the expression of a real, demonstrable sequence of sufficiently frequent occurrence to afford ground for the rough approximation which suffices to constitute a popular weather law.

But it does not follow that because we assume the fact of an apparent connection between two phenomena, and predict from the manifestation of the one the approaching manifestation of the other, the connection must necessarily be of the nature of cause and effect, nor yet of the nature of successive effects of the same cause. There is such a thing as the coincidence of phenomena. The coincidence may be purely fortuitous, or it may be the result of the operation of higher laws of which we as yet have no knowledge.

We may now proceed to the more immediate subject of this article. It is not my intention to attempt to give an exhaustive collection of lunar proverbs. Such collections are curious, but they are not particularly useful. Nor do I aspire to propound any new theory of lunar influence on the weather. What I do propose is to discuss a few of the best known, and therefore most important, of the popular weather notions in which the moon is concerned, with the view of showing the necessity for discrimination in their acceptance; the ultra-scientific man who pooh-poohs everything that has moon in it being really as wide of the mark as the poor victim of superstition who puts double faith in things on the same ground. In arranging my remarks it will be convenient to deal successively with (1) lunar notions that are utterly absurd; and (2) those that are explicable by the aid of physical principles, and are therefore rational and useful in practice.

To the former class belongs the idea, in its various forms, of a direct lunar influence; and I would begin with that most ubiquitous —and apparently everlasting as well—of all popular absurdities, the table known as "Herschel's Weather Table." How it ever came to be associated with the name of the greatest of English astronomers is a mystery. I once put the question in "Notes and Queries," where the obscurest of literary enigmas are often solved, but to no purpose. Whatever the explanation may be, the table is certainly weighted with Herschel's great authority, and to this day we find it in nearly all the almanacs, and even in some less ephemeral publications, gravely quoted as the embodiment of scientific truth. It is not necessary to take up space with the whole table, as it is only too well known, and can be seen in almost any almanac. It states that if the moon changes, or becomes full, or enters her first or third quarter between noon and two in the afternoon, the "resulting weather" (that is, I presume, the weather during the ensuing week, or until a new change inaugurates a new state of things) will be, in summer, "very rainy," and in winter "snow and rain." If the change of moon takes place between two and four in the afternoon, the resulting weather will be "changeable" in summer (a pretty safe prediction in this climate), and "fair and mild" in winter. And so on for the whole twenty-four hours. Now, it will be observed that the lunar influence assumed here is of an occult nature. There is no pretense of physical agency in the matter. The weather will be such and such, not because the moon's reflection of light is greater or smaller, nor because her radiation of heat is more or less, nor because her position with respect to the earth is nearer or farther away, but simply because she "changes" between certain arbitrary hours. What virtue there can be in the moon's "change" is hard indeed to see. The principle involved must be an astrological one, for in reality the moon is gradually, if imperceptibly, "changing" during every moment of her increase from new to full, and her decrease from full to new again, the quarters being only stages in the process specially marked for the sake of convenience. There is precisely the same degree of visible difference between a three-days'-old moon and a ten-days'-old one as there is between a new moon and a moon in her first quarter; but in the former case (so we are asked to believe) the difference is impotent to rule the weather because it does not coincide with the conventional "change." To look at the matter in another way, it will be noticed that the table provides for a change occurring at any hour in the twenty-four, and, as the moon can not escape the necessity of changing sometimes, it follows that the weather for the year—and not only for the year, but for as long as the sun, earth, and moon retain their relative position and motions—is reducible to a cut-and-dry order; such an order, no doubt, as the compilers of Zadkiel's, Orion's, and the Belfast Almanacs assume. Need the British public be assured that no such convenient orderliness in our

weather phenomena exists? And, finally, the "changes" of the moon are not exclusively confined to England, nor to any one country. The new moon waxes into the full moon simultaneously all the world over. Moreover, the "change" takes place simultaneously all the world over. Consequently, when the change occurs between 12 and 2 P. M., it means that the weather will be "very rainy" in every part of the earth where summer is, while "snow" must prevail wherever the conditions are such as to make rain impossible; and what becomes of those local variations which are the experiences of everybody who has traveled twenty miles upon the terrestrial globe? Predictions founded upon this preposterous weather table are not one whit more worthy of serious attention than those contained in Zadkiel's Almanac; but, while the latter are admittedly addressed only to the grossly ignorant and credulous, the table unfortunately retains its character of respectability unimpaired.

As an example of elaborate nonsense, I know of nothing better than a table "showing the probabilities of a change of weather at or after each of the moon's situations throughout an entire revolution in her orbit," which received the honor of recognition and approval in a cyclopædia of not very ancient date. The table names the moon's ten "situations" (conjunction, opposition, first quarter, third quarter, perigee, apogee, ascending equinox, descending equinox, northern lunistice, and southern lunistice), and opposite each gives the "chances that the weather will change" with the most exquisite exactitude. Thus, there are six chances to one that a change will take place about new moon, but only five to two in favor of a change about the full. At the time of the northern lunistice the chances are eleven to four, at the southern three to one (note the minute difference). Unlike Herschel's table, this one has reference to a lunar "influence" which depends for its intensity, as any physical influence necessarily would do, upon the nearness or distance of its source, and also upon the position of that source relative to the sun, which may be regarded as the seat of an opposing or antagonistic influence. This is all quite rational, and is well calculated to impress the unscientific mind, while the exquisite precision with which the probabilities are stated, greatly enhances the effect. But what is the outcome of it? Taking the ten specified points in each lunation, and calling a lunation, roughly, thirty days, and then averaging the "probabilities," we discover that this table, which looks for all the world as if it might be the condensed result of years of observation and much laborious calculation, merely expresses (or, more properly speaking, conceals) the simple fact, that in every three days there are about three chances to one that the weather will undergo a change!—which, so far as this country is concerned, is only too true.

"If Christmas comes during a waxing moon we shall have a very good year; and the nearer to the new moon the better. But if, during

the waning moon, a hard year; and the nearer the end of the moon, so much the worse." This saying is typical of a good many others. The fact that a festival is invariably selected, points to a purely superstitious origin, for we have no physical grounds for supposing a festival-day to determine the weather conditions which are to follow any more than an ordinary day. Unlike the tables we have been discussing, there is not even the semblance of scientific authority here. The chief agent is not physical, but religious. The moon is always either waxing or waning; it is her nature so to do. But that of itself signifies nothing; it is when Christmas happens upon a waxing or waning period that we have the critical combination.

Southey, in one of his letters, writes: "Poor Littledale has this day explained the cause of our late rains, which have prevailed for the last six weeks, by a theory which will probably be as new to you as it is to me. 'I have observed,' he says, 'that when the moon is turned upward, we have fine weather after it; but if it is turned down, then we have a wet season: and the reason, I think, is, that when it is turned down it holds no water, like a basin, you know, and then down it all comes.'" Southey found, upon inquiry, that this was a common notion in the lake district. George Eliot, as Mr. Harley points out, has a reference to the same fancy in "Adam Bede." If Jamieson's "Scottish Dictionary" is to be trusted, the same belief is exactly reversed in Scotland. Jamieson states that it is considered as an almost infallible presage of *bad* weather if the moon "lies sair on her back." Of the two forms of the saying, the English one is infinitely to be preferred, for it embodies rather a pretty idea, while the Scotch one is simply nonsensical. The moon might "lie sair on her back" were it she herself that was "bad," but scarcely on account of an approaching disturbance of the weather. To explain the conditions under which the crescent moon is tilted forward or backward, would require little short of a treatise on the lunar and terrestrial motions, a digression for which we have no space; but it is sufficiently obvious that to attribute an influence to the "attitude" of the visible moon is open to the fatal objection that, like the "change," it is not a sudden but a gradual phenomenon, which ought to exercise its influence through all the stages of its progress, instead of only when a weather-wise person happens to notice it.

One of the most curious, and certainly one of the most widespread, of all weather beliefs is that of the "Saturday moon." The notion is that when the new moon falls on a Saturday it is invariably followed by a period of wet and unsettled weather. The currency of this belief is remarkably wide. Not only is it found (more or less modified) in the folk-lore of England, Scotland, and Ireland, but it is held also by seamen of all nationalities. A traveler relates that he once heard it referred to by a Chinese pilot. And more than this, in 1848, a Dr. Forster announced to the Royal Astronomical Society, as the result of an

examination of weather registers kept by his grandfather, his father, and himself, extending over nearly eighty years, that nineteen times out of twenty a new moon on Saturday was followed by twenty days of rain and wind. It is not many weather sayings that enjoy the supporting testimony of a sober scientific investigation, and that circumstance, together with the general acceptance in which the saying is held, entitles it to special consideration.

Could we reduce the occurence of a Saturday moon to any form of periodicity—that is to say, were the accident of the new moon falling on a Saturday to recur at regular intervals—we should have some ground for at least provisionally admitting the truth of the rule, since we know that many weather phenomena are roughly periodical (though the periodicity is often completely masked by the disturbing operation of local influences), and it might so happen that this weather period coincided with that of the Saturday moon. The "cold snaps" in May, for example, recur periodically; and a cause for the phenomenon has been found in the passage of dense meteor flights between the sun and the earth, the meteors intercepting a portion of his heat. But the Saturday moon is not exactly periodical. In 1881 not a single new moon fell on a Saturday. In 1883 there were three conjunctions so distinguished. This year there are two. What sort of weather period can we imagine guilty of such eccentricities? Of course, had the adage referred to a particular Saturday moon it would have been different. The new moon falls on the same day again after a lapse of about nineteen years (a circumstance that gave rise to the Metonic cycle), and the rule would then have meant that a period of wet and windy weather occurred at a certain season every nineteen years—a notion in striking accordance with a favorite cycle of the cycle hunters. No such interpretation is possible, however, and we are obliged to include this much-respected saying in the category of idle superstitions.

We come now to the more edifying class of lunar weather notions—those that have a real physical basis. And it may not be out of place to repeat here that the writers who so emphatically and unreservedly denounce the moon and weather idea a vulgar superstition overstep the limits of scientific truth. So far as any influence of the kind we have been considering is concerned, they are quite right. The moon exerts no influence upon our atmosphere strong enough, by comparison with the other influences at work, to produce a marked correspondence between the lunar and atmospheric phenomena. Of that we are certain. Let us, therefore, belabor the false doctrine upon which the preceding and many similar notions are founded with all our might. But because the moon certainly is not a dominant factor in our weather, it does not follow that we are justified in denying to it an influence of any kind. And the results of sundry investigations have been such as to render it prudent to regard the existence of *some* physical connection between the two as at least an open question. Atmos-

pheric tides, due to the moon's attraction, must exist, unless the whole theory of gravitation be wrong, and in a few cases they have been successfully traced in the barometrical records; but in general they are totally obliterated by the ordinary and very much larger disturbances due to other causes. The heating effect of the moon's rays has been the subject of several careful experiments. Melloni, in 1846, started the investigation, and since then Piazzi Smyth (on Teneriffe) and Lord Rosse (at Parsonstown) have endeavored to make precise determinations, with results that place beyond doubt the fact that moonlight does contain a minute proportion of heat-rays, mostly of the dark sort. More recently, Professor Langley's experiments with the bolometer have confirmed that conclusion. In the face of such results, insignificant though they admittedly are by comparison with the effects popularly attributed to lunar influence, it is not correct to say that science absolutely discountenances the notion of any connection between the moon and the weather. For although a barometrical fluctuation so slight as to defy most efforts to discover it, and a thermometrical effect so infinitesimal as to require a very elaborate as well as delicate apparatus to detect it, can not in any sense be called "weather," it is not unfair to assume—granted the physical influence—that it may work upon the atmosphere in ways to which our instrumental results afford no clew.

We have an example of this in the circumstance which no less careful an observer than Sir John Herschel remarked, "without any knowledge of such a tendency having been observed by others"—the circumstance that the sky is clearer, generally speaking, about the time of full moon than when she is in her quarters. Humboldt mentions this as a fact well known to the pilots and seamen of Spanish America. The explanation has been suggested that clear nights are more *conspicuous* when the moon is full than when the stars alone diffuse their feeble glimmer, and that clearness in the one case is likely to arrest the attention and be remembered more readily than in the other. One might be disposed to accept the explanation did not Herschel plainly state the tendency to disappearance of clouds under the full moon as a meteorological fact; and he was too experienced an observer to be easily misled by an illusion of the memory. Now, both Lord Rosse's experiments with the three-foot mirror, and those of Professor Langley with the bolometer, have proved that the lunar heat-rays are chiefly dark rays; and Tyndall has shown that "dark heat" is very ready to undergo absorption. It may, therefore, be inferred that much of the heat sent to us by the moon—the quantity of which varies with her phase—is absorbed by the aqueous vapor in the higher regions of the atmosphere; and the direct result of this must be to raise the temperature of the air above the clouds, cause increased evaporation from their surface, and so effect, in a certain measure, their dispersion. Again, a necessary consequence of the dispersion of

the clouds is increased radiation from the earth's surface, producing a reduction of temperature in the air near the ground; and Mr. Park Harrison, who discussed a series of temperature observations made at Oxford, Greenwich, and Berlin, found a mean decrease of more than 2° F. about the time of full moon. The French proverb of *la lune rousse*, which Louis XVIII bewildered Laplace by asking him to explain, may be accounted for by the aid of these researches. The name of "red moon" is applied to the moon which is full at the end of April or early in May, because during the clear nights which then prevail, the tender leaves and buds are frozen and turn red; and popular superstition attributes this effect to the peculiar action of the "red moon's" rays. It is at least curious that the connection assumed in this superstition between the full moon, clear nights, and May frosts should be one that is suggested by independent scientific results.

Apart from any question of lunar influences, however, there are many popular prognostics which make use of the moon merely as a convenient exhibitor of certain atmospheric effects — effects which would not be visible without the moon to show them up, but in the production of which that orb plays no part whatever; and in so far as sweeping denunciations of lunar weather proverbs include these, discredit is thrown on a class of useful sayings very unjustly.

There is, perhaps, no better known lunar prognostic than that referred to in the old Scotch ballad of Sir Patrick Spens:

"O ever alack! my master dear,
I fear a deadly storm.
I saw the new moon late yestreen,
Wi' the auld moon in her arm;
And if ye gang to sea, maister,
I fear will suffer harm."

Chambers, in "The Book of Days," says that to see "the old moon in the arms of the new one" is reckoned a sign of *fine* weather—another curious example of how sayings get twisted; but in that statement he is quite wrong. The appearance is almost universally held to be a sign of bad weather. Two explanations have been offered to account for the prognostic, in each of which there is undoubtedly a measure of truth. When the moon appears "new" to us, the earth would appear "full" to the lunar inhabitants, if there were any; and what causes the dark part of the young moon to be dimly visible is its reflection of the brilliant earth-shine. The earth, however, will not always shine with equal brilliance, even when the same amount of surface is illuminated, for obviously clouds reflect more light than either land or sea. Hence, when an unusual illumination of the night-side of the moon is apparent, it shows that the earth-shine is exceptionally strong, which in turn is an indication of the presence of a large amount of cloud in our atmosphere. Further, as a moment's consideration will prove, the cloud area must lie to the west of us, the direction from

which we receive most of our storms; so that the apparition of the old moon in the arms of the new, virtually means that there are vast cloud-banks over the North Atlantic Ocean which, in all probability, are drifting up to us, and will, before long, bring us "dirty" weather. I am not disposed to go so far as Mr. John Aitken, who, in a paper recently read before the Royal Society of Edinburgh, suggested the use of the moon's dark limb as an "outlying signal station," but it is satisfactory to know that this venerable prognostic has a sound physical basis, and is as worthy of respect as ever it was. The other explanation to which I referred is the greater "visibility" of the air which generally precedes rough or unsettled weather, this clearness allowing the ghostly disk of the old moon to loom forth in a way it could not do through a misty atmosphere. Though, doubtless, a part explanation of the phenomenon, it is not a whole one, and must be taken along with the other.

The halo is an old sign of bad weather:

> "When round the moon there is a brugh,
> The weather will be cold and rough."

Of sixty-one lunar halos observed in the neighborhood of London, thirty-four were followed by rain within twenty-four hours, nineteen by rain within four days, and only eight by no rain at all. The cause of halos is the formation of an extremely attenuated form of cloud which floats in the van of all cyclonic disturbances. Messrs. Abercromby and Marriott, who made a detailed comparison between a number of popular weather prognostics and the actual distribution of weather as disclosed by synoptic charts, found the lunar halo to be a true sign of the approach of a "cyclone" or area of depression, just as a clear moon indicates the presence of an anti-cyclone, or area of high pressure, with the likelihood of cold or frost. Similarly, a pale or watery moon marks the advent of a disturbance, while the blunting of the cusps is due to the same cause, and has the same significance. The variation of this last prognostic, which makes a sullied lower horn the sign of foul weather before the full, and a sullied upper horn the sign of foul weather about the wane, is purely fanciful.

Just one word about that enticing object of research—as fascinating in its way as perpetual motion or the exact value of π—the lunar circle.

Dr. E. B. Tylor, says: "The notion that the weather changes with the moon's quarterings is still held with great vigor in England. That educated people to whom exact weather records are accessible should still find satisfaction in the fanciful lunar rule, is an interesting case of intellectual survival." I am willing to be with the foremost in combating such absurdities as "Herschel's Weather Table," and all theories which would assign to the lunar phases an immediate control of our weather; but it so happens that the notion Dr. Tylor condemns is one for which there may be some foundation. A moon's quarter is roughly equivalent to a week, and Mr. Carpmael, the Di-

rector of the Canadian Meteorological Department, once told me that he had very frequently noticed a tendency in the weather to change and repeat itself every seven days. A similar seven-day periodicity has been observed in the United States. The meteorological conditions of a large continent, it must be remembered, are simpler than those of our own little islands, and hence it is possible that a cycle almost completely masked here might disclose itself there. It is not to be supposed that I am contending for a cycle due to the moon. I only wish to point out that there is some evidence of the existence of a seven-day weather period, which may sometimes happen to be coincident with the lunar phases; and if this be really so, it is not at all wonderful that our forefathers were led to infer a connection, or that even "educated people" continue to put a certain amount of faith in a rule so well founded.

But pre-eminently *the* lunar cycle is that of eighteen and a half years—the ancient Saros, or period of revolution of the lunar node. It has been traced in sundry phenomena, including the amount of rainfall and the recurrence of epidemic pestilences. The evidence, of course, is extremely shaky, though scarcely more so than much of that adduced in favor of the sun-spot cycle. The truth seems to be that in certain lines of inquiry, if an investigator starts with a predetermined system of any kind, statistics will bear him out, or can be made to bear him out.

In closing this hasty survey of a branch of mixed knowledge and ignorance, science combined with superstition, I would repeat the observation with which I set out (and which I have now in a measure justified), that it is unfair to stigmatize the whole moon-and-the-weather theme as unworthy of serious treatment—as a mere surviving fragment of astrology. There is a great deal of nonsense in it, more nonsense than sense; and if the two must sink or swim together, it would be better to let the sense go than to preserve both. But why should they be inseparable? We have sifted a little grain out of much chaff before now; and there is this great gain in the result, that the sifted chaff *is* chaff, obviously, demonstrably, and can not lay claim to a spurious value in the eyes of the short-sighted by the admixture of a proportion of the valued thing. There are weather wiseacres who *know* that there is truth in some of their cherished lunar proverbs; and the unconditional repudiation of every saying with moon in it by men of science simply convinces these old fellows that the men of science do not understand what they are talking about, and makes them cling all the more vigorously to their ill-used beliefs. If we were to set about it in a different way, and to accept the sayings that science can sanction, and only repudiate the rest, we would have a better chance of success in combating this irrepressible error. For it is the truth in the error that makes it irrepressible.—*Longman's Magazine.*

ANIMAL AGENCY IN SOIL-MAKING.

By Professor N. S. SHALER.

THE admirable studies of Mr. Darwin on the influence of earth-worms upon the soil has made it clear that these animals exercise a most important effect in its preparation for the use of plants. Mr. Darwin's luminous essay has served to call attention to the effect of organic life on the development of the soil-coating. In the following pages I propose to submit the results of some studies of a general nature, which serve to show that a number of other animals have a considerable influence on the preparation of soils.

Our soils, as is well known, depend upon a variety of actions which serve to break up the rocky matter of the earth, and to commingle that matter with organic materials more rapidly than the erosive agents can remove the *detritus* from the point at or near which it decays. For the formation of the soil two actions, at least, are essential. First, the bed-rock must be broken into fragments sufficiently separated from each other to permit the passage of roots between them; second, the rock fragments must be still further comminuted and commingled with organic waste to make the combination of organic and inorganic matter on which the utility of the soil absolutely depends. Although the earth-worms are undoubtedly very important agents in overturning and breaking up of soil, it appears to me that they are most effective in the tilled fields or in the natural and artificial grass-lands. So far as I have been able to observe, these creatures are rarely found in our ordinary forests where a thick layer of leaf-mold, commingled with branches, lies upon the earth. The character of this deposit is such that the creatures are not competent to make their way through it, and they therefore in the main avoid such situations. Moreover, wherever the soil is of a very sandy nature, earth-worms are scantily found if they are present at all. These worms are practically limited to the soils of a somewhat clayey character, which have no coating of decayed vegetation upon them.

As the greater portion of the existing soil has been produced in forest regions, I shall first examine the action of various animals upon the soils of wooded countries. The mammals are, of all our vertebrates, the most effective in their action upon the soil of forests. Twenty species or more of our American mammals are burrowers in the forest-bed. They either make their habitations beneath the ground, or resort to it in the pursuit of food. Of these, our burrowing rodents are perhaps the most effective, but a large number of other small mammals resort to the earth and make considerable excavations. In forming their burrows, or in the pursuit of other burrowing animals, these creatures often penetrate through the whole or greater portion of the soil-covering. The material which is withdrawn from the burrow is accumulated

about its mouth. The result is the overturning of a considerable amount of the earth, and a consequent commingling of the material with vegetable matter. When brought to the surface and left exposed to the action of frost, the breaking up of the material is greatly favored, and thus the formation of the soil is facilitated.

Considerable as is the effect of burrowing mammals, the principal overturning of the earth in our primeval forests is accomplished by the invertebrate animals. Where the woods are not very dense, and particularly where the soil is somewhat sandy, our largest species of ants are very effective agents in working over the soil. Their burrows extend to the depth of some feet below the surface, and each hill brings to the air several cubic feet of excavated matter, which, as slight inspection shows, is much commingled with vegetable matter. Wherever these ant-hills abound they commonly exist to the number of a score or more on each acre, and the occupants of each hill, in many cases, bring as much as a cubic foot of matter to the surface in the course of a single year. The action of rain constantly operates to diffuse this material on every side of the hill. We may often observe a thin layer of sediment extending for a considerable distance from the elevation.

As is well known to all those who have inspected the soil within virgin forests, the earth is occupied by a host of larval insects, principally belonging to the group of beetles, but including also many orthopterous insects. These creatures, in the course of their life underground, displace a good deal of soil, a portion of which is thrown upon the surface, the greater part, however, being merely dislodged beneath the surface. The effect, however, is to commingle and to break up the soil, and thus favor its comminution. Although the roots of trees do by far the larger part of the rending which is accomplished in the soil-layer, they do not bring about much commingling of the soil. The thrusts which they apply to it shear the materials about, and so, to a certain extent, mix them, but by far the larger part of the commingling is effected by the animal life which dwells beneath the forest-bed.

Where the woods are wet and favor the development of the cray-fish, the effect of this group of animals on the overturning of the soil is extremely great. It probably exceeds that which is accomplished in our ordinary fields by the action of the earth-worms. A single cray-fish will often bring in the course of a single season's activity not less than half a cubic foot of earthy matter to the surface. In certain districts where these animals abound, there appear to be not less than a thousand to each acre of surface. If such be their number, it is evident that not less than five hundred cubic feet of matter is brought to the surface from a considerable depth in the course of a year. As this matter is generally of a rather fine nature and easily dissolved in water, it rapidly washes away and forms a thin sheet on the surface.

I am inclined to believe that large areas of our wet woods and the open border-lands along our streams are completely overturned to the depth of two feet or more in the course of half a century by the actions of these animals. It is not impossible, indeed, that the very fine division of the soil which characterizes the regions inhabited by these creatures may be in good part due to their action. In this manner the creatures may have in part worked to bring about the very conditions which best serve their needs.

In open grounds, in natural prairies or grass-plains, the smaller species of ants are extremely effective agents in overturning the soils. Wherever the ground remains for some time unplowed it becomes occupied by these creatures. In the sandy soils of Eastern Massachusetts, the overturning accomplished by these creatures assumes a geological importance. For many years I have been puzzled by the fact that the glacial terraces and plains of this region were extensively covered to the depth of a foot or more by a coating of fine sand and very small pebbles, while below the depth of a foot pebbles of larger size are very numerous, and the spaces between them but imperfectly occupied with any material. It is obviously impossible to explain these conditions through the action of earth-worms, for the reason that these creatures are rarely found in soils of this description. From much observation I have become convinced that this coating of sandy material is, to a great extent, to be explained by the action of various species of ants in the forest condition by the work of the larger black ants, and in the condition of open plains by that of the smaller species.

The amount of material which these creatures bring to the surface in a single season is surprising. At several points in Eastern Massachusetts I have found the surface to contain at least one ant-hill to each square foot of area, or about forty thousand hills to the acre. This is, probably, an exceptionally great number; it will, perhaps, be safer to estimate the number at twenty thousand to the acre. The incoherent heaps of excavated matter which these creatures form are quickly washed away by the rain, or in many cases, are blown away by strong winds, and so scattered over the surface. As soon as destroyed they are, in most cases, rebuilded, the result being that a single hill is reconstructed at least half a dozen times during a season. I have estimated that the amount of material brought to the surface often exceeds three cubic inches to each square foot of surface in a single year, or about a fiftieth of an inch of the whole area each year. Thus, in the term of fifty years, the accumulation of material on the surface would amount to as much as an inch, and reckoning the soil as having an average depth of one foot, a total overturning would be accomplished in less than a thousand years. It is likely that in some cases, over considerable areas, a tolerably complete overturning is brought about in less than a quarter of this time.

The effect of this action of ants on the soil-material is peculiar. The tendency is like that noted by Mr. Darwin in the case of earth-worms to bring the finer particles to the surface. I am inclined to think the ants accomplished this part of their work even more effectively than the earth-worms, for the reason that they penetrate more deeply between the stones than their less active associates. Like the earth-worms, but in larger measure, the ants convey considerable amounts of organic matter into the soil. Their winter store of food is deeply buried, and much of it remains unconsumed in the nether earth. There is thus a constant inhumation of vegetable matter beneath the materials which they bring to the surface.

Although the burrowing vertebrates operate most vigorously in the forest-covered regions, they also exercise a certain influence on the open country. The moles which work only here and there in the forest are conspicuous agents in overturning the soil in the grassed regions. Still, as this group is peculiarly limited in its distribution, and rarely penetrates to more than four or five inches below the surface, it exercises a relatively small effect. The field-mice are more potent agents in effecting the character of the soil. Their dwelling-chambers are at a considerable depth below the surface, and in forming them, they bring a certain amount of matter to the open air, moreover the remains of their food, as well as their excrements, are important contributions to the organic matter of the soil. Insects in their larval stage exercise a less effect in the open field than in the forest-covered regions; still, they are not to be left out of account in considering the process of soil-making in such areas. In Europe the rabbit, which has a habit of burrowing to a considerable depth, and in certain districts west of the Mississippi, the prairie-dog, overturn the soil on the areas they occupy with considerable rapidity. Still, as the number of these creatures in any given district is not great, their influence is mostly exercised in a very local way.

The foregoing considerations make it tolerably clear that our ants are, in some districts, by far the most important agents in overturning the soil and in commingling the superficial organic matter with the mineral material of which it is composed. Although on a field of a certain class those which are of a clayey nature, the earth-worms, are probably more efficient soil-makers than the ants, this latter group appears to be, at least in the eastern part of North America, on the whole, by far the most effective in the preparation of the soil for the needs of plants. They do not, it is true, take the soil into their bodies and thus disintegrate it, as the earth-worms do, but they accomplish what is perhaps the more important task of rapidly overturning the soil-material as well within the forests as in the open fields wherever that material is of a sandy nature.

THE TIME IT TAKES TO THINK.

By J. McK. CATTELL.

ALL science is partly descriptive and partly theoretical. Care must, however, be taken lest too much theory be built up without sufficient foundation of fact, or there is danger of erecting pseudo-sciences, such as astrology and alchemy. The theories of the conservation of energy and of the evolution of species are more interesting to us than the separate facts of physics and biology, but facts should be gathered before theories are made. The way of truth is a long way, and short cuts are apt to waste more time than they save. Psychology is the last of the sciences, and its present business seems to be the investigation of the facts of consciousness by means of observation and experiment. Everywhere in science experiment is worth more than observation; it is said that the evidence in pathology is so contradictory that almost anything can be proved by clinical cases. Psychology, owing to its very nature, must always depend largely on observation for its facts, and some progress has been made in spite of the difficulties lying in the way of introspection and the correct interpretation of the actions of others. The application of experimental methods to the study of mind is, however, an important step in advance, and would seem to be a conclusive answer to those who, with Kant, hold that psychology can never become an exact science. I propose explaining here how we can measure the time it takes to think, and hope this example may show that the first fruits of experimental psychology are not altogether insignificant or uninteresting. Just as the astronomer measures the distance to the stars and the chemist finds atomic weights, so the psychologist can determine the time taken up by our mental processes. It seems to me the psychical facts are not less important than the physical; for it must be borne in mind that the faster we think, the more we live in the same number of years.*

It is not possible directly to measure the time taken up by mental processes, for we can not record the moment either of their beginning or of their end. We must determine the interval between the production of some external change which excites mental processes, and a movement made after these processes have taken place. Thus, if people join hands in a circle, and one of them, A, presses the hand of his neighbor B, and he as soon as possible afterward the hand of C, and so on round and round, the second pressure will be felt by each of the persons at an interval after the first, the time depending on the number of people in the circle. After the hand of one of the persons

* The results I am about to give are based on experiments, detailed accounts of which I have printed in recent volumes of "Mind," "Brain," and "Philosophische Studien."

has been pressed an interval very nearly constant in length passes before he can press the hand of his neighbor. This interval, which we may call the reaction-time, is made up of a number of factors. A period elapses before the pressure is changed into a nervous message or impulse. This time is very short in the case of touch ; but light working on the retina seems to effect chemical changes in it, and these take up some little time, probably about one fiftieth of a second. After a nervous impulse has been generated it moves along the nerve and spinal cord to the brain, not traveling with immense rapidity like light, but at the rate of an express train. In the brain it must move on to a center having to do with sensation, where changes are brought about, through which a further impulse is sent on to a center having to do with motion, and a motor impulse having been prepared there is sent down to the hand. Another pause, one two hundredth to one one hundredth of a second, now occurs, while the muscle is being excited, after which the fingers are contracted and the reaction is complete. The entire time required is usually from one tenth to one fifth of a second. The reaction-time varies in length with different individuals and for the several senses, but as long as the conditions remain the same the times are very constant, only varying a few thousandths of a second from each other. One may wonder how it is possible to measure such short times and with such great accuracy. It would not be easy if we had not the aid of electricity ; but when it is called to mind that a movement made in London is almost instantaneously registered in Edinburgh, it will not seem inconceivable that we can record to the thousandth of a second the instant a sense-stimulus is produced and the instant a movement is made. The time passing between these two events can be measured by letting a tuning-fork write on a revolving drum. The tuning-folk can be regulated to vibrate with great exactness, say five hundred times a second ; it writes a wavy line on the drum, each undulation long enough to be divided into twenty equal parts, and thus time can be measured to the ten thousandth of a second.

The psychologist is chiefly interested in what goes on in the brain and mind. It seems that about one half of the entire reaction-time is spent while brain changes take place, but we know very little as to these changes, or as to how the time is to be allotted among them. It is probable that in the case of the simple reaction the movement can be initiated before the nature of the impression has been perceived. We can, however, so arrange the conditions of experiment that the observer must know what he has seen, or heard, or felt, before he makes the movement. He can, for example, be shown one of a number of colors, and not knowing beforehand which to expect, be required to lift his finger only when red is presented. By making certain analyses and subtracting the time of the simple reaction from the time in the more complex case, it is possible to determine with considerable

WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.*

By Professor EDWARD S. MORSE.

[*Concluded.*]

TO those who have already been startled by the memoir of Dr. W. Baldwin Spencer on the presence and structure of the pineal gland in Lacertilia, and the evidence that it represents a third eye in a rudimentary condition, it will be interesting to know that among some of the earlier mammals the pineal gland may have assumed functional importance as an eye. Professor Henry F. Osborn † shows that in the skull of the curious mammal Tritylodon, of Owen, there is seen a parietal foramen in exactly the same position and relation as in the lizard Sphenodon.

Professor Osborn regards this fact of remarkable interest, as it adds greatly to the rapidly accumulating evidence for the reptilian affinities of the mammalia. Professor Owen, in the description of this unaccountable opening, suggested that it might be due to posthumous injury.

Professor Marsh, ‡ in a description of the skull of Diplodocus, a Dinosaur, describes a fontanelle in the parietal on the median line directly over the cerebral cavity. He adds, however, that this may be merely an individual variation.

Professor Cope * observes an enormous fronto-parietal foramen in the skull of *Empedocles molaris*, a curious creature from the Permian.

It would appear evident from these facts that at one time the pineal gland, which in the mammals is in a rudimentary condition, and in certain Lacertilia sufficiently perfect, as an eye, to be sensitive to light impressions at least, was, in certain extinct mammals and reptiles, of large size and functionally active. It is a significant fact that no sooner does some one opposed to evolution undertake to lay down the law by setting a boundary to type-features, than a discovery is made that breaks down the barrier. Thus, Dr. Thomas Dwight, ‖ in an interesting memoir on the "Significance of Bone Structure," in which he makes a brave defense for teleology, says, in speaking of the persistence of the vertebrate plan, "There are never, for instance, more than two eyes or one mouth or two pairs of limbs," and, lo! an extra eye is immediately added.

* Address of the retiring President of the American Association for the Advancement of Science, delivered at the New York meeting, August 10, 1887.

† "Science," vol. ix, p. 114.

‡ "American Journal of Science and Arts," vol. xxvii, p. 161.

* "Proceedings of the American Philosophical Society," 1878, p. 516.

‖ "Memoirs of the British Society of Natural History," vol. iv, No. 1.

Dr. Spencer Trotter* has made a study of the collar-bone and its significance, in which he accounts for its presence or absence in mammalia by correlating it with the life-habits of the animal in the use of the fore-limb. He says: "Every fully-developed tissue in an organism is needed, or it would not be there; and just so soon as by increasing change in life and habits it becomes a factor of less and less importance to the animal, it fails more and more to attain its former standard of development, and in time falls back to the primitive condition from which it arose and finally disappears."

Many new and interesting facts have been added sustaining the affinity between the birds and reptiles. Professor O. C. Marsh† made a careful study of the Archæopteryx in the British Museum. The new points he has added bring out still more strongly the extraordinary characters blended in this creature. Among other features he discovered the separate condition of the pelvic bones, and shows that while it must be considered a bird, yet it has true teeth, bi-concave vertebræ, three separate fingers in each hand, all furnished with claws, metatarsals and metacarpals, equally unanchylosed and the pelvic bones separate, as already mentioned.

Dr. J. Amory Jeffries,‡ in the study of the claws and spurs on birds' wings, has presented an interesting table showing the number of phalanges in each finger, from the highest to the lowest family of birds, with the presence or absence of claws recorded for each finger. This table shows very clearly that the higher birds have fewer phalanges and no claws, and as one approaches the lower families the phalanges increase in number, the first finger having two phalanges, and the second and third fingers being tipped with claws.

In a brief study of the tarsus of low aquatic birds,* made with special reference to the interpretation of the ascending process of the astragalus with the intermedium of reptiles, I observed a separate center of ossification for this so-called process, observed its unquestionable position between the tibiale and fibulare, its increase in size with the growth of the bird, and its final anchylosis with the proximal tarsal bones. In the bones of a young Dinornis, which through the courtesy of Dr. Henry Woodward I was kindly permitted to examine in the British Museum, the ascending process was large and conspicuous and firmly anchylosed with the coössified tarsals to the distal end of the tibia. Professor Marsh,‖ in a study of the metartasal bones of Ceratosaurus, a Dinosaur discovered by him, found that the metatarsals coössified in the same manner as those of the penguin.

The question as to the existence of a sternum in Dinosaurian

* "American Naturalist," vol. xix, p. 1172.

† "American Journal of Science and Arts," vol. xxii, p. 338.

‡ "Proceedings of the British Society of Natural History," vol. xxi, p. 301.

* "Anniversary Memoirs of the British Society of Natural History," 1880.

‖ "American Journal of Science and Arts," vol. xxviii, p. 161.

reptiles has long been in doubt. Professor Marsh* has, however, discovered in Brontosaurus, one of the largest known Dinosaurs, two flat bones which he regards as clearly belonging to the sternum. They correspond to the immature stage of similar parts in birds.

Dr. Alexander Agassiz,† in a study of the young stages of certain osseous fishes, shows that while the tail is a modified heterocercal one, it is for all that in complete accordance with embryonic growth and paleontological development; and, independently, Dr. John A. Ryder‡ finds that "the median fins of fishes normally present five well-marked conditions of structure which correspond inexactly to as many stages of development, which, in typical fishes, succeed each other in the order of time."

Mr. James K. Thatcher,# in a study of the "Median and Paired Fins, a Contribution to the History of Vertebrate Limbs," shows that "the limbs, with their girdles, were derived from a series of similar simple parallel rays, and that they were a specialization of the continuous lateral folds or fins evidenced in embryos, which were, with some probability, homologous with the lateral folds or metapleura of the adult Amphioxus."

A great amount of work has been done in making clear the earlier stages in the development of animals, and breaking down the hard and fast lines which were formerly supposed to exist between the larger divisions. Dr. C. S. Minot,‖ in a series of papers on "Comparative Embryology," in referring to the work accomplished, says: "These researches have completely altered the whole science of comparative anatomy and animal morphology, by entirely upsetting a large part of Cuvier's classification and the idea of types upon which it was based, substituting the demonstration of the fundamental identity of plan and structure throughout the animal kingdom, from the sponges to man."

Professor C. O. Whitman,^ in describing a "rare form of the blastoderm of the chick, in which the primitive groove extended to the very margin of the blastoderm, terminating here in the marginal notch first observed by Pander," justly contends that, "in the origin of the embryo from a germ-ring by the coalescence of the two halves along the axial lines of the future animal, and, secondly, in the metameric division which followed in the wake of the concrescence," we have evidence of the annelidan origin of the vertebrates, since concrescence of the germ-bands is a well-established fact for both chætopods and leeches.

* "American Journal of Science and Arts," vol. xix, p. 395.

† "Proceedings of the American Academy of Arts and Sciences," vol. xiii, p. 117.

‡ "American Naturalist," vol. xix, p. 90.

"Transactions of the Connecticut Academy of Arts and Sciences," vol. iii, p. 281.

‖ Ibid., vol. xiv, p. 96.

^ "Proceedings of the British Society of Natural History," vol. xxii, p. 178.

The tracing of apparently widely divergent structures to a common origin has engaged the attention of many of our investigators. Not only has a large amount of evidence been offered to show a common origin of widely-separated structures, but memoirs of a speculative and theoretical character have given us a possible clew to the avenues we may follow in further establishing a proof of the unity of origin of forms and parts.

Dr. Francis Dercum * gives an interesting review of the structure of the sensory organs, and urges that the evidence goes to prove the common genesis of these organs.

Professor A. Hyatt † has presented an interesting study of the larval history of the origin of tissue. He attempts to show a phyletic connection between the Protozoa and Metazoa, and also to show that the tissue-cells of the latter are similar to a sexual larvæ, "and are related by their modes of development to the Protozoa, just as larval forms among the Metazoa themselves are related to the ancestral adults of the different groups to which they belong." Dr. John A. Ryder ‡ has studied the law of nuclear displacement and its significance in embryology. In a discussion of this subject he says: "The mode of evolution of the yolk is of great interest, and doubtless occurred through the working of natural selection. It is evidently adaptive in character, and the necessity for its presence as an appendage of the egg grew out of the exigencies of the struggle for existence."

Mr. H. W. Conn,# in a paper entitled "Evolution of the Decapod Zoæ," gives a number of striking and suggestive facts explaining the reason of the multiform and diverse character of the larvæ of decapod crustaceans. He shows in what way natural selection has affected the young. What has seemed an almost insoluble mystery, as to why the early stages of closely allied crustaceans should be so often diverse in their varied armature of long spines, their powers of rapid flight, etc., are explained on the ground of natural selection. In another memoir by the same author, ‖ on the significance of the "Larval Skin of Decapods," a very complete discussion of the views of authors is given. At the outset he shows that the crustaceans are a particularly favorable group for the study of phylogeny, and then suggests the character of the ancestral form of the Crustacea from the significance of the larval envelope. The author infers, from his studies, that "all decapods are to be referred back to a form similar to the *Protozoœ* (*Zoœ*), in which the segments of the thorax, and probably of the abdomen, were present, and whose antennæ were locomotive organs."

Not the slightest justice can be done this admirable discussion in the

* "American Naturalist," vol. xii, p. 579.

† "Proceedings of the British Society of Natural History," vol. xxiii, p. 45.

‡ "Science," vol. i, p. 273. # Ibid., vol. iii, p. 513.

‖ "Studies from Biological Laboratory," Johns Hopkins University, vol. iii, No. 1.

brief reference here made, but the perusal of it will certainly impress one with the profound change which has taken place in the method of treating a subject of this nature compared to the treatment it might have received in pre-Darwinian days. Indeed, the features discussed in this paper would not have attracted a moment's attention from the older naturalists.

Since Darwin published his provisional theory of Pangenesis it has provoked speculative efforts on the part of some of our naturalists to devise other hypotheses which might answer some of the objections urged against Darwin's hypothesis. Space will permit only a mention of a few of these papers. Professor W. K. Brooks * presented, in brief abstract, at the Buffalo meeting eleven years ago, a provisional theory of Pangenesis. These views, more elaborated, are now published in book-form, under the title of "The Laws of Heredity." An illustrious reviewer says it is the most important contribution on the speculative side of Darwinism that has ever appeared in this country. He has also aptly termed studies of this nature molecular biology. Dr. Louis Elsberg at the same meeting also read a paper on the plastidule hypothesis.

Dr. John A. Ryder † has made an interesting contribution entitled "The Gemmule *versus* the Plastidule as the Ultimate Physical Unit of Living Matter." In this paper he discusses Darwin's provisional theory of Pangenesis, and shows it to be untenable from Galton's experiments.

Haeckel's provisional hypothesis of the perigenesis of the plastidule is clearly stated, and he closes by saying that the logical consequences of the acceptance of Haeckel's theory, and with it the theory of dynamical differentiation—because the latter is no longer an hypothesis—forever relegate teleological doctrines to the category of extinct ideas.

The wide-spread public interest in Darwinism arose from the fact that every theory and every fact advanced in proof of the derivative origin of species applied with equal force to the origin of man as one of the species. The public interest has been continually excited by the consistent energy with which the Church—Catholic and Protestant alike—has inveighed against the dangerous teachings of Darwin. Judging by centuries of experience, as attested by unimpeachable historical records, it is safe enough for an intelligent man, even if he knows nothing about the facts, to accept promptly as truth any generalization of science which the Church declares to be false, and conversely to repudiate with equal promptness as false any interpretation of the behavior of the universe which the Church adjudges to be true. In proof of this sweeping statement, one has only to read the impos-

* "Proceedings of the American Associated Antiquarian Society," vol. xxv, p. 177; also "American Naturalist," vol. xi, p. 144.

† "American Naturalist," vol. xiii, p. 12.

ing collection of facts brought together by Dr. White, the distinguished ex-President of Cornell University, which are embodied in his work entitled "The Warfare of Science," as well as two additional chapters on the same subject, which have lately appeared in "The Popular Science Monthly." One then realizes the lamentable but startling truth that, without a single exception, every theory or hypothesis, every discovery or generalization of science has been bitterly opposed by the Church, and particularly by the Catholic Church, which resists, and, as Huxley says, "must, as a matter of life and death, resist the progress of science and modern civilization."

Only the briefest reference can here be made to a few of the numerous contributions on the subject of man's relationship to the animals below him. The rapidly-accumulating proofs of the close relation existing between man and the quadrumana, make interesting every fact, however trivial, in regard to the structure and habits of the higher apes.

Dr. Arthur E. Brown* has made some interesting experiments with the monkeys at the Zoölogical Gardens in Philadelphia. He found that the monkeys showed great fear, as well as curiosity, when a snake was placed in their cage, though they were not affected by other animals, such as an alligator and turtle. On the other hand, mammals belonging to other orders showed no fear or curiosity at a snake. These experiments, repeated in various ways, lead him to only one logical conclusion, "that the fear of the serpent became instinctive in some far-distant progenitor of man, by reason of his long exposure to danger and death in a horrible form, from the bite, and that it has been handed down through the diverging lines of descent which find their expression to-day in Homo and Pithecus."

The same author,† in an exceedingly interesting description of the higher apes, says: "Mr. A. R. Wallace once called attention to the similarity in color existing between the orang and chimpanzee and the human natives of their respective countries. It would, indeed, seem as if but half the truth had been told, and that the comparison might be carried also into the region of mind; the quick, vivacious chimpanzee partaking of the mercurial disposition of negro races, while the apathetic, slow orang would pass for a disciple of the sullen fatalism of the Malay."

Dr. Brown‡ has also given a description of the grief manifested by a chimpanzee on the death of its mate. His grief was shown by tearing his hair or snatching at the short hair on his head. The yell of rage was followed by a cry the keeper had never heard before, a sound which might be represented by *hah-ah-ah-ah-ah* uttered somewhat under the breath, and with a plaintive sound like a moan.

Mr. W. F. Hornaday* read at the Saratoga meeting of this Asso-

* "American Naturalist," vol. xii, p. 225.
† Ibid., vol. xvii, p. 119.
‡ Ibid., vol. xiii, p. 173.
* Ibid., vol. xiii, p. 712.

ciation an exceedingly interesting paper on the "Habits of the Orang," as observed by him in his native forests. He says, "Each individual of the Borneo orangs differs from his fellows, and has as many facial peculiarities belonging to himself alone, as can be found in the individuals of any unmixed race of human beings." After recounting the many traits of the orang, heretofore regarded as peculiar to man, he says: "Let any one, who is prejudiced against Darwinian views, go to the forests of Borneo. Let him there watch from day to day this strangely human form in all its various phases of existence. Let him see it climb, walk, build its nest, eat and drink and fight like human 'roughs.' Let him see the female suckle her young and carry it astride her hip precisely as do the coolie women of Hindostan. Let him witness their human-like emotions of affection, satisfaction, pain, and childish rage—let him see all this, and then he may feel how much more potent has been the lesson than all he has read in pages of abstract ratiocination."

Professor W. S. Barnard several years ago, in a study of the myology of man and apes, showed that the scansorius muscle which Trail studied in the higher apes and which he supposed had no homologue in man, was really homologous with the *gluteus minimus* in man. Dr. Henry C. Chapman,* in a study of the structure of the orang-outang, has confirmed the truth of Barnard's discovery. Dr. Chapman is led to infer that the ancestral form of man was intermediate in character, as compared with living anthropoids or lower monkeys, agreeing with them in some respects and differing from them in others.

The osteological affinities which man has with the *Lemuridæ*, as insisted upon by Mivart, are also recognized by Cope.† In a general paper on the "Origin of Man and other Vertebrates," he says: "An especial point of interest in the phylogeny of man has been brought to light in our North American beds. There are some things in the structure of man and his nearest relatives, the chimpanzee, orang, etc., that leads us to suspect that they had rather come from some extinct type of lemurs."

It would seem as if we must look farther back than the higher apes for the converging lines of man's relations with them. The earliest remains of man or the apes found fossil, presenting as they do marked types with little tendency to approach one another, would in themselves suggest an earlier origin for both stocks.

In a paper by Professor Cope ‡ on "Lemurine Reversion in Human Dentition," he says, in concluding his article: "It may be stated that the tritubercular superior molars of man constitute a reversion to the dentition of the *Lemuridæ* of the Eocene period of the family *Anap-*

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1880, p. 168.

† "Popular Science Monthly," vol. xxvii, p. 609.

‡ "American Naturalist," vol. xx, p. 941.

tomorphidæ, and second, that this reversion is principally seen among Esquimaux and the Slavic, French and American branches of the European race."

In another paper by the same author* on the "Developmental Significance of Human Physiognomy," he compares the proportions of the body and the facial peculiarities of man with the higher apes and human infants, and shows that the Indo-European, on the whole, stands higher than the other races in the acceleration of those parts by which the body is maintained in an erect position, and in the want of prominence of the jaws and cheek-bones, which are associated with a greater predominance of the cerebral part of the skull and consequently greater intellectual power.

Dr. Harrison Allen,† in a study of the shape of the hind-limb as modified by the weight of the trunk, dwells on the manner of articulation in the gorilla of the fibula with both calcaneum and the astragalus, as well as the fact that the astragalus in that genus possessed a broad, deflected fibula facet, and says: "This peculiar projection is rudimental in the astragalus of civilized man, but was found highly developed in an astragalus from an Indian grave found at Cooper's Point, New Jersey."

In my Buffalo address, I alluded to a paper by Professor N. S. Shaler on the intense selective action which must have taken place in the shape and character of the pelvis in man on his assumption of the erect posture—the caudal vertebræ turning inward, the lower portion of the pelvis drawing together to hold the viscera, which had before rested on the elastic abdominal walls, the attending difficulty of parturition, etc. Dr. S. V. Clevenger‡ has since called attention to other inconveniences resulting from man's escape from his quadrumanous ancestors. In a paper entitled "Disadvantages of the Upright Position," he dwells particularly on the valves in the veins to assist the return of blood to the heart, which, considered from the usual teleological point of view, seems right enough; but why, he asks, should man have valves in the intercostal veins? He shows that in a recumbent position these valves are an actual detriment to the flow of blood: "An apparent anomaly exists in the absence of valves from parts where they are most needed, such as the venæ cavæ, spinal, iliac, hæmorrhoidal, and portal. The azygos veins have important valves. Place man upon 'all-fours,' and the law governing the presence and absence of valves is at once apparent, applicable, so far as I have been able to ascertain, to all quadrupedal and quadrumanous animals. Dorsad veins are valved; cephalad, ventrad, and caudad veins have no valves." By means of two simple diagrams he shows clearly the distribution of valved and unvalved veins as they exist in

* "American Naturalist," vol. xvii, p. 618.

† "Proceedings of the Philadelphia Academy of Natural Sciences," 1885, p. 383.

‡ "American Naturalist," vol. xviii, p. 1.

mammals, and why in man the same arrangement becomes detrimental. He dwells on the number of lives that are sacrificed every year by the absence of valves in the hæmorrhoidal veins. He also mentions other disadvantages in the upright attitude, as seen in the position of the femoral artery, even with man's ability to protect it. Its exposed condition is a dangerous element. Inguinal hernia of rare occurrence in mammals occurs very often in man, at least twenty per cent being affected. Strangulated hernia also causes many deaths. Prolapsus uteri and other troubles and diseases are referred to by Dr. Clevenger as due to the upright position. In other words, the penalties of original sin are in fact the penalities resulting from man's assumption of the erect posture.

In another paper by the same author,* on the "Origin and Descent of the Human Brain," he gives an interesting sketch of the phylogenesis of the spinal cord to its ultimate culmination in the development of the brain of man. He says that the most general interest centers in the large mass of cells and nerve-fibers called the cerebrum. "In the ornithorhynchus it is smooth and simple in form, but the beaver also has an unconvoluted brain, which shows at once the folly of attaching psychological importance to the number and intricacy of folds in animal brains. With phrenology, which finds bibativeness in the mastoid process of the temporal bone, and amativeness in the occipital ridge, the convolutional controversies must die out, as has the so-called science of palmistry, which reads one's fate and fortune in the skin-folds of the hand."

Professor Alexander Graham Bell† has presented a memoir to the National Academy on the "Formation of a Deaf Variety of the Human Race," in which he shows by tables a series of generations of certain families in which the progenitors being deaf-mutes this peculiarity becomes perpetuated in many of the descendants. Recognizing fully the laws of heredity, natural selection, etc., he shows that the establishment of deaf-mute schools, in which a visual language is taught which the pupils alone understand, tends to bring them into close association with one another; and that naturally, with this seclusion, acquaintance ripens into friendship and love, and that statistics show that there is now in process of being built up a deaf variety of man.

Dr. W. K. Brooks,‡ animated by the cogency of Professor Bell's reasoning, is led to prepare an article entitled "Can Man be Modified by Selection?" In this paper he discusses the startling proposition of Professor Bell, and recognizes the convincing proof which he furnishes to show that the law of selection does place within our reach a powerful influence for the improvement of our race. The striking character of the tables of facts presented by Professor Bell, and the significant

* "American Naturalist," vol. xv, p. 513.

† "Memoirs of the National Academy of Science," vol. ii, fourth memoir.

‡ "Popular Science Monthly," vol. xxvii, p. 15.

suggestions of Dr. Brooks, lead one to consider how far the influence of selection has had to do with the character of great communities, as to their intelligence or ignorance. When we see nations of the same great race-stock, one showing a high percentage of illiterates, a high death-rate, degradation and ignorance, while just across the borders another nation, apparently no better off so far as physical environments are concerned, with percentage of illiterates and death-rate low, intelligent and cleanly, we are led to inquire if here a strict scientific scrutiny with careful historical investigation will not reveal the cause of these conditions. Can it be proved beyond question that the illiteracy and degradation of Italy and Spain, up to within recent years at least, is the result of centuries of church oppression and the Inquisition, destroying at once or driving out of the land all independent thinkers, and at the same time forcing her priests to lead celibate lives and inducing others of cultivated and gentle minds to lead cloister lives? Is it also a fact, as Alphonse de Candolle asserts, that by far the greater number of distinguished scientists have come from Protestant pastors? He gives a significant list of eminent men whose fathers were Protestant pastors, saying that, had they been priests of another religion, leading celibate lives, these men would not have been born.

It is considered an intrusion into matters which do not concern science when such inquiries are made, but the scientist has very deeply at heart the intellectual and moral welfare of the community. If the cause of degradation and ignorance, of poverty, of contagious disease, or of any of the miseries which make a nation wretched, can be pointed out by scientific methods, then it is the stern duty of Science to step in and at least show the reasons, even if the remedy is not at once forthcoming. The men who would be reformers and agitators, and who by their earnestness and devotion get the attention of multitudes, are unfit for their work if they show their ignorance, as most of them do, of the doctrines of natural selection and derivation.

Dr. C. S. Minot* read a paper before the Cincinnati meeting of this Association, suggesting a rather startling proposition as to whether man is the highest animal, which led Dr. W. N. Lockington† to reply in a very able article entitled "Man's Place in Nature."

The great problem of food-supply has led to legislative enactments for the purposes of regulating the trapping and netting of game and fish. State and Government grants have been made for fish commissions; but, unless the public are clearly educated in the rudiments of zoölogical science and the principles of natural selection, appropriations will come tardily and in limited amounts. Dr. W. K. Brooks,‡ in his report to the State of Maryland as one of the oyster commissioners, after showing the absurd way in which the problem of oyster-protection has

* "Proceedings of the American Associated Antiquarian Society," vol. xxx, p. 240.

† "American Naturalist," vol. xvii, p. 1003.

‡ "Report of the Oyster Commissioners of Maryland," 1884, p. 31.

been dealt with, and strenuously urging the necessity of oyster-culture, calls attention to the fact that "civilized races have long recognized the fact that the true remedy is not to limit the demand, but rather to increase the supply of food, by rearing domestic sheep and cattle and poultry in place of wild deer and buffaloes and turkeys, and by cultivating the ground instead of searching for natural fruits and seeds of the forests and swamps."

Mr. Ernest Ingersoll,* author of the "Report on the Oyster-Industry," tenth United States census, has, in an address before the Geographical Society of New York, a striking sketch of the effect of the white man on the wild animals of North America, showing that, had the Indians remained in possession, little if any change would have taken place. The Indian, like the predaceous animals, hunts only for food, and shows even in this habit a wholesome self-restraint, never killing wantonly. He called attention to the survival of a number of small birds about the dwellings of man as the result of favorable conditions, such as a constant supply of food, etc. He shows that the contact of man in the main has been disastrous. His remarks on the oyster are timely; he shows its extermination along the coast by man's agency. "Hardly more than a century has elapsed since men believed that the oyster-beds of New York were inexhaustible, and that a small measure of legal protection, feebly maintained, was quite enough to sustain them against any chance of decay. So they thought in Massachusetts, where the oysters have not only disappeared but have been forgotten. So they think now in Maryland and Virginia, where their fond expectations are destined to equal downfall."

Professor William H. Brewer,† in a paper on the "Evolution of the American Trotting-Horse," shows that the trotter is an American product, and that it is still in process of evolution. He gives a column of figures to show the speed that has been attained in this new form of motion, from a speed of three minutes in 1818 down to two minutes ten and a quarter seconds in 1881. The materials for a curve is offered to mathematicians, and Professor Francis E. Nipher,‡ in a mathematical article on the subject, shows that a definite time of ninety-one seconds will ultimately be attained by the American trotter! Mr. W. H. Pickering,* however, urges some objections to the deductions of Professor Nipher.

In drawing to a close this very imperfect summary of what American zoölogists have accomplished for evolution many other distinguished contributors might have been mentioned. The work of eminent physiologists and paleontologists has hardly been considered,

* "Bulletin of the American Geographical Society," 1885, No. 1.

† "American Journal of Science and Arts," vol. xxv, p. 299.

‡ "St. Louis Academy of Sciences," May 7, 1883; also "American Journal of Science and Arts," vol. xxvi, p. 20.

* "American Journal of Science and Arts," vol. xxvi, p. 378.

nor has the long array of botanical facts for Darwin as revealed in the fascinating study of the relations which exist between flowering plants and insects, contrivances for cross-fertilization, means of plant-dispersion, etc., and the distinguished botanists connected with this work, received attention here. Indeed, the proper limits for an address of this nature have been far exceeded.

Suffice it to say that all these students have worked from the standpoint of derivative doctrines. A still greater triumph to Darwinism are the evidences of gradual conversion still going on among a few isolated workers who still remain stubborn, yet yielding to the pressure of these views by admitting features that ten years ago they repudiated.

There are two points to be emphasized here in closing: and one is, that American biological science stands as a unit for evolution; and the other is, the establishment of a great generalization, which shows that when intelligence became a factor in animals, it was seized upon to the relative exclusion of other characteristics. This generalization offers an unassailable argument to-day for a wider, broader, and deeper education for the masses. The untold misery and suffering of the working-classes, as witnessed in their struggles of the last two years, would have been avoided had the rudiments of social science—even a knowledge of the value and significance of simple statistics—been appreciated by them.

The startling paper of Dr. Seaman* on the "Social Waste of a Great City" shows the blundering, criminal way in which municipalities are controlled by coteries ignorant alike of Science and the beneficent mission she stands waiting to enter upon.

[Within ten years a number of general works on evolution have appeared, the most important of which have been the "Law of Heredity" by Dr. W. K. Brooks, to which allusion has already been made; and the "Origin of the Fittest," by Professor E. D. Cope, in which are brought together the various papers, memoirs, addresses, etc., of the author which have appeared from time to time in scientific journals and magazines. Nearly all the addresses read, within the past ten years, before this Association by the presiding officers who were zoölogists have been imbued with Darwinism and deriviation. The titles of the general articles which have appeared on evolution would fill a large catalogue.

The general addresses on the subject are legion. Indeed, as the revered botanist Asa Gray has well remarked, "Dante literature and Shakespeare literature have been the growth of centuries, but Darwinism filled teeming catalogues during the lifetime of the author."

While no reference can be made to these various publications, allusions must be made to the Darwin Memorial Meeting of the Biologi-

* "Science," vol. viii, p. 283.

cal Society of Washington as containing a most appreciative *résumé* of the labors of the great naturalist. A perusal of the addresses on that occasion brings to mind very vividly the comprehensive scope of the work of this great man. The Introductory, by Professor Theodore Gill, is a strong sketch of the wonderful revolution wrought in the methods and convictions of naturalists by the doctrines of Darwin. Of great interest and value also are the succeeding addresses read at that meeting, which were—a "Biographical Sketch," by Dr. William H. Dall; "The Philosophical Bearings of Darwinism," by Major John W. Powell; "Darwin's Coral Island Studies," by Mr. Richard Rathbun; "Darwin's Investigations on the Relation of Plants and Insects," by Professor Charles V. Riley; "Darwin as a Botanist," by Mr. Lester F. Ward; "Darwin on Emotional Expression," by Mr. Frank Baker; closing with "A Darwinian Bibliography," by Mr. Frederick W. True.]

EMOTIONS *VERSUS* HEALTH IN WOMEN.

By MARY T. BISSELL, M. D.

WHEN the harassed and wretched Macbeth inquired of the doctor, "Canst thou not minister to a mind diseased?" his candid physician promptly disclaimed any such high qualifications. "Therein," said he, "the patient must minister to himself."

It is possible that the modern physician would appear less modest under a similar interrogation, since modern hygiene claims the entire man for its operations, concerning itself not only with his physical, but also with his mental good. Keenly alive to the intimate relations existing between mind and body, it often throws upon the physician of to-day the responsibility of determining whether the remedy indicated be chemical or spiritual. This broad outlook embraces large and small interests, and may certainly include one feature in the training of women which, we believe, is opposed to her best growth and health. We refer to a tendency which exists in her education to an undue stimulation of her emotional nature.

Woman is believed to have been endowed by Nature with a strongly emotional temperament. She is accepted as the fairest exponent of sentiments, which in turn lend her her chiefest charm. Tears and smiles, emotion and sensibility, are expected of her. It is permitted to her to be a blue-stocking if she will, but sympathetic and tender she must be. If Hypatia has her admirers, all the world loves Juliet! It is precisely in that natural aptitude for emotion, in that type of mind which is exquisitely sensitive to impressions and generously swayed by sympathetic feeling, that one of the great dangers to the perfection of womanhood, physical and mental, may be said to reside.

Many and varied influences tend to increase this emotional excita-

bility until it often becomes a fixed habit of mind; an undue sensibility of the supreme centers to emotional ideas is created, which can only be maintained at the expense of sound health of body and of mind. First among these are certain home influences that are brought to bear upon a little girl from her earliest childhood, which foster in her self-consciousness and introspection.

She is generally permitted narrower limits, within which she can play, can dress, can succeed, than are allowed to her brother, even when her physique is equally able. She is housed more closely, her out-of-door sports are fewer and less interesting, and her dress is too often a limitation to her freedom. Such restrictions of her liberty, and constant reference to the fact that her sex denies her this or that employment or pleasure, tend to make a child self-conscious and emotionally overactive. Methods of family discipline which depend upon appeals to the emotional natures of children have like unhealthy results, for they promote a condition of mental commotion and unrest harmful to children, who require an even atmosphere for the mind as well as for the body. There are often undue claims made upon little children for the demonstration of their affections, and this is especially true of girls.

In a paper on "Emotional Prodigality among Children," read before a dental society some years ago by Dr. C. F. Taylor, it was argued that stimulation of the emotions among children conduced not only to diseases of the spine, but also to dental caries.

Dr. Taylor says: "In my large practice among children, I am certain that scores are literally killed by the excessive amount of emotional excitement which they are forced to endure. All this hugging and kissing and talking to them is to excite responses of the same emotional nature in the child for the pleasure and gratification of the parents and friends." And again he says: "I believe that three fifths of the spinal diseases which occur in children are directly traceable to mental overaction. And this because a large proportion of these cases gets well without other treatment than a withdrawal from the exciting cause of emotional disturbance." The writer does not subscribe to this view of the causation of lateral curvature, except in so far as any influence which weakens the body may be a factor in this affection, but the opinion is of interest as suggesting the extent of this and kindred influences.

The literature which little girls are permitted to read may be held responsible for much emotional stimulation of an unhealthy character. If a man be known by the company he keeps, it is equally true that he is known by the books he reads. The last quarter of a century has opened a wide vista of healthful delight for children through the green fields of modern child literature, but the prospect is not yet entirely fair. The hot-house atmosphere prevails in many volumes, which owe their birth to the present decade.

I recall a very popular series of girls' books, widely read at the present time, in which the emotional natures of the little heroines are continually maintained at concert pitch from the strain put upon them by appeals to affection, to conscience, to inordinate love of praise, etc. I have often been astonished to see intellectually promising and otherwise sensible little girls devouring pages of unhealthy sentiment such as would fill their robust little brothers with scorn and repugnance.

We need only briefly refer to the unhealthy influence exerted upon the minds of little girls by foolish indulgence in showy dress or in social dissipation. Dissipation, indeed, is a serious term to apply to the social pleasures of little children, but, when we hear of children's parties beginning at nine o'clock, in which toilets and manners only suitable for their mammas are encouraged, we easily conclude that, in the lack of simplicity in social customs, we may find an abnormal stimulus to the emotional natures of American girls.

Certain school influences have a large responsibility in this direction. What is called the hot-house pressure of public schools, and the elaborate system of examinations in our higher institutions of learning, have their evil not in the exercise of the calmer faculties of the mind, such as judgment, reason, memory, etc., but in their tendency to arouse that complex emotion called *worry*. These influences are exerted, it is true, upon girls and boys alike, but, as the facility of the girls for emotional disturbance is greater, they suffer more largely per consequence. The repeated stimulation of such complex emotions can not fail to agitate the mind of young girls, and insidiously disturb its calm.

As the girl grows to womanhood, the impression made by these influences upon her plastic child nature can not be entirely thrown off. If she be of a strong and womanly type, she will meet the physical and social trials of life with such character and self-possession as she may, but they will have for such a one a double force. Life offers only too many facilities for overtaxing the sympathies of the unduly sensitized individual. The appeals of misery, poverty, and sorrow sound in every ear. The woman who would maintain a just equilibrium between sentimental mourning and efficient sympathy for these facts of existence needs to be re-enforced, not weakened, by the education of her childhood. And if to the friction of any life we add the strain of an elaborate social system, if our young woman be a society girl, with all the demands of a high-bred life of fashion upon her time, temper, versatility, and self-control, we have one more influence which maintains her at constantly high emotional pressure.

It is evident that the sum of these and similar forces constantly exerted upon the mind of women must have their due effect. The normal result of the stimulation of any organ of the body is well known to be a final loss of health in that organ. When the faculties of the mind, called out in the display of the emotions, are overtaxed,

we generally find either a lack of will-power or a deficiency in reason and judgment, and our common expression for that condition is that such an individual is not well balanced.

It is possible that some of us have heard it suggested that woman is a less reasonable being than man. It has, indeed, been whispered that she—regarding her as a type, not as an individual—is less logical, less temperate in her judgments, more easily controlled by appeals to the feelings. In the recent article by Ouida in the "North American Review," speaking of the character of a woman's mind, she says: "The female mind has a radical weakness, which is often also its peculiar charm; it is intensely subjective; it is only reluctantly forced to be impersonal." Such opinions are not entirely unfamiliar to any of us.

We are in no wise concerned for the final judgment of mankind upon the mind of woman, nor do we imagine that it requires championship. But it is easily apparent that this very grace of her nature may be turned to bad account through undue stimulation, and that, through inheritance and the influences we have briefly suggested, she may acquire a tendency toward an unduly subjective type of mind—a tendency which threatens the loss of a just intellectual sense of proportion, and which, therefore, can not conduce to sound mentality.

The old meaning of the word emotion—*commotion*—is opposed to the best mental growth and health. In repose, in the quiet harmonious performance of its functions, the mind grows into vigorous maturity, and the constant unrest and commotion of nerve-elements, which accompany violent emotional disturbances, and repeated strain upon other than its reasoning faculties, can not fail to disturb the quiet, natural evolution of its powers. Can this tendency in woman's training be shown to affect her bodily health? Physicians and metaphysicians answer, Yes!

The intimate relation which exists between the mind and the body is a matter of familiar knowledge to us all. The tear that starts from the eye when grief disturbs the mind is a common instance of the effect which an intangible mental emotion has upon the physical basis of the lachrymal gland. The loss of consciousness and the heart-failure which may follow great mental shock, and the deleterious effect which mental anxiety may exercise upon digestion, are, unfortunately, matters of common experience. Even the poetical allusion to the hair which grows white in a single night has its basis in physiological fact. The miracles claimed by the faith-curers are in the same line of argument, for they indicate how far sedation of the mind may be an adjuvant to the cure of the body.

Says Maudsley: "It may be questioned whether there is a single act of nutrition which emotion may not affect, infecting it with feebleness, inspiring it with energy, and so aiding or hindering recovery from disease. It is certain that joy or hope exerts an animating effect

upon the bodily life, quiet and equable when moderate, but when stronger, evinced in the brilliancy of the eye, in the quickened pulse, in an inclination to laugh and sing; grief, or other depressing passion has an opposite effect, relaxing the arteries, enfeebling the heart, making the eye dull, impeding digestion, and producing an inclination to sigh or weep." This exaggeration of the emotions, seen in many cases among women, may be considered a serious factor in inducing some of the most common diseases of the nervous system from which Americans, in particular, are suffering.

In his treatise on the causes of these nervous diseases Dr. Ross, of London, says: "Psychical disturbances are a prolific source of disease of the nervous system, and it is probable that as civilization advances these causes will exercise a more and more predominant influence in the production of nervous disease. The depressing passions, such as fright, alarm, disgust, terror, and rage, have, no doubt, in all ages, exerted a deleterious influence on the nervous system; but in the present day the keen competition evoked by the struggle for existence in the higher departments of social life must subject the latest evolved portion of the nervous system to a strain so great, that those only possessing the strongest and best balanced nervous system can escape unscathed." Of these nervous diseases, nervous exhaustion and hysteria were never more rife than to-day.

As regards the occurrence of hysteria, while it is frequently found among those belonging to what we call the lower classes of society, it is more frequently manifested among the more highly cultivated. A French author who, indeed, speaks for his own country only, states that one out of four of all females are decidedly affected with hysteria, and that one-half present an undue impressionability which differs very little from it. Although these statistics are too high for America, they are significant as being possible anywhere, and not the less so as coming from a land where, if a woman is anything, she is emotional.

Among the frequent causes of hysteria, all writers mention the depressing passions, such as fear, anxiety, jealousy, and remorse. One says: "The chief mental characteristic of hysterical patients is an excessive emotional excitability unchecked by voluntary exertion." And again: "This excessive emotional activity necessarily induces exhaustion." The treatment of this affection recognizes, first and last, the influence of mind over body. We find that moral suasion, the employment of the individual in directions without herself, the cultivation of an intellectual purpose, of an objective quality of mind, are remedies that rank with the nervines and antispasmodics in the treatment of this disorder.

As regards nervous exhaustion, we find that affection is almost entirely confined to the more highly civilized portions of the community —indeed, is a disease of civilization. Among the causes of nervous exhaustion this same truth is manifest—that excessive demands upon

the individual exciting the complex emotions of anxiety, *worry*, are largely responsible for inducing this affection. We believe, indeed, that hard work, unaccompanied by emotional excitement, seldom injures either man or woman. It is the man who, in addition to close application to work, is harrassed by fears of poverty, of loss of position, of anxieties for himself or his family, and the woman who bears the burden of domestic cares, of private griefs, or sustains the strain of a complex social system, who suffers from nervous exhaustion, not the hard-working mechanic, or the unemotional washer-woman. The experience of every school-girl testifies that mental anxiety produces a degree of physical exhaustion out of all proportion to the muscular work effected. The agitations of school politics, the over-emotional character often infused into school-girl friendships, the fears of failure and kindred commotions result in more physical weariness than hours of calm, steady work in the laboratory or in the class-room.

A college graduate confesses that one of the most exhausting experiences of her college life was a morning spent in absolute physical inactivity in a student's meeting, but in a state of mental commotion impossible to describe, over an absorbing issue in college politics. "After four hours of that experience," she said, "I was fit for bed, and for nothing else." It requires no great ingenuity to suggest that this tendency in the training of woman which affects her mental and physical health, may be met by remedies addressed to body and mind alike. The education which shall discipline, not eradicate, the emotional susceptibility of women must begin where the gentility of Dr. Holmes's ideal gentleman began, with our great-grandmothers.

Heredity may not be able to shoulder all of the sins of mankind, but, at least, it must bear its share. The coming woman must not only be well-born, she must be bred in more hygienic methods. She must not only possess inherited vigor, she must also be educated nearer to Nature. The genuine child of Nature is not a morbidly emotional child. The girl who lives in the open air, who knows every bird and flower and brook in the neighborhood, has neither time nor inclination to spend in reading the sentimental histories of departed child-saints, and takes small delight in morbid conversation.

Out-of-door life has never been made popular or interesting for little girls as it always has been for boys. Girls will voluntarily seek fresh air and sunshine if they appreciate the delightful occupations as well as the *fun* to be found in it. They are quite right in "hating to go out because there is nothing to do." Open wide to them the fascinating book of Nature; let them read the story of bird-life and animal-life, and find their first hints of the wonders of plants and rocks by sunlight, and at first hand, not from a printed page in unventilated libraries. Then, when out-of-door life and out-of-door sports have been made as attractive and popular for girls as for boys, and when they have accepted the creed that a nobly-developed and

active body is as much their birthright and glory as it has always been the glory of their brothers, we shall find we have gone a long way toward reducing exaggerated emotions in women. And if our first antidote for this condition lies in physical activity and in the cultivation of a sound body, the second antidote will be found in the provision of constant, congenial employment for the mind.

When a young woman went to Henry Ward Beecher to ask him to prescribe for her disappointed affections, he promptly advised her to begin the study of the higher mathematics! There is no doubt but that among the less apparent, but no less real causes of undue emotional development among women we may count the lack of congenial and effective work. There is nothing sanitary in intellectual idleness. Physiology forbids that the inactive brain should be a healthy one. The overworked individual may suffer from undue strain, but the mind which is denied congenial employment suffers even a worse penalty in the disability of its best powers, and the waste of purposeless energy.

Women who are receiving the so-called higher education, find in its discipline and opportunity the best remedy for any tendency to excessive emotional disturbance. "The worst enemy of the emotions is the intellect." There is no stronger argument for opening to women new avenues for the acquisition of knowledge than these facts of her constitution offer, justified as the experiment has been by those who have found life a better and a broader thing to them because of these opportunities.

Undoubtedly the actual erudition that is gained in a collegiate training for women could be obtained under other conditions than in the four years of college life. But the inestimable value of our women's colleges lies not so much in their opportunities for actual learning, as in the atmosphere they offer. To live for four years under a *régime* where mental and physical energy are carefully utilized and disciplined, and where the tendency is toward the development of an objective type of mind and the cultivation of a broad intellectual outlook—these are incalculable benefits to woman.

Give to our children, our growing girls, and our young women occupation which, according to their age and capacity, shall develop every faculty of the mind and afford genuine scope for usefulness, and we shall find that the energy which might have been dissipated in unproductive emotions, has been diverted into channels of effective work, and conserved for high and healthful ends.

THE most recent measurements of skeletons indicate that the ancients were not superior to the moderns in stature, but may have been inferior. The average heights of two lots of Romano-British skeletons ranged from four feet ten inches for women to five feet two inches for the larger men; and the average height of twenty-five mummies in the British Museum is fifty-five inches for females and sixty-one inches for males.

ASTRONOMY WITH AN OPERA-GLASS.

THE STARS OF WINTER.

By GARRETT P. SERVISS.

I HAVE never beheld the first indications of the rising of Orion without a peculiar feeling of awakened expectation, like that of one who sees the curtain rise upon a drama of absorbing interest. And certainly the magnificent company of the winter constellations, of which Orion is the chief, make their entrance upon the scene in a manner that may be almost described as dramatic. First in the east come the world-renowned Pleiades. At about the same time Capella, one of the most beautiful of stars, is seen flashing above the northeastern horizon. These are the sparkling ushers to the coming spectacle. In an hour the fiery gleam of Aldebaran appears at the edge of the dome below the Pleiades, a star noticeable among a thousand for its color alone, besides being one of the brightest of the heavenly host. The observer familiar with the constellations knows, when he sees this red star which marks the eye of the angry bull, Taurus, that just behind the horizon stands Orion with starry shield and upraised club to meet the charge of his gigantic enemy. With Aldebaran rises the beautiful V-shaped group of the Hyades. Presently the star-streams of Eridanus begin to appear in the east and southeast, the immediate precursors of the rising of Orion:

> "And now the river-flood's first winding reach
> The becalmed mariner may see in heaven,
> As he watches for Orion to espy if he hath aught to say
> Of the night's measure or the slumbering winds."

The first glimpse we get of the hero of the sky is the long bending row of little stars that glitter in the lion's skin which, according to mythology, serves him for a shield. The great constellation then advances majestically into sight. First of its principal stars appears Bellatrix in the left shoulder; then the little group forming the head, followed closely by the splendid Betelgeuse, "the martial star," flashing like a decoration upon the hero's right shoulder. Then come into view the equally beautiful Rigel in the left foot, and the striking row of three bright stars forming the Belt. Below these hangs another starry pendant marking the famous sword of Orion, and last of all appears Saiph in the right knee. There is no other constellation containing so many bright stars. It has two of the first magnitude, Betelgeuse and Rigel; the three stars in the Belt, and Bellatrix in the left shoulder, are all of the second magnitude; and besides these Orion contains three stars of the third magnitude, and more than a dozen of the fourth, besides innumerable twinklers of smaller magnitudes,

whose commingled scintillations form a celestial illumination of singular splendor.

"Thus graced and armed he leads the starry host."

By the time Orion has chased the Bull half-way up the eastern slope of the firmament, the peerless Dog-Star, Sirius, is flaming at the edge of the horizon, while farther north glitters Procyon, the Little Dog-Star, and still higher are seen the twin stars in Gemini. When these constellations have advanced well toward the meridian, as shown in our circular Map No. 1, their united radiance forms a scene never to be forgotten. Counting one of the stars in Gemini as of the first rank, there are no less than seven first-magnitude stars ranged around one another in a way that can not fail to attract the attention and the admiration of the most careless observer. Aldebaran, Capella, the Twins, Procyon, Sirius, and Rigel mark the angles of a huge hexagon, while Betelgeuse shines with ruddy beauty not far from the center of the figure. The heavens contain no other naked-eye view comparable with this great array, not even the glorious celestial region where the Southern Cross shines supreme, being equal to it in splendor.

To counterbalance the discomforts of winter observations of the stars, the observer finds that the softer skies of summer have no such marvellous brilliants to dazzle his eyes as those that illumine the hyemal heavens. To comprehend the real glories of the celestial sphere in the depth of winter one should spend a few clear nights in the rural districts of New York or New England, when the hills, clad with sparkling blankets of crusted snow, reflect the glitter of the living sky. In the pure frosty air the stars seem splintered and multiplied indefinitely, and the brighter ones shine with a splendor of light and color unknown to the denizen of the smoky city, whose eyes are dulled and blinded by the glare of street-lights. There one may detect the delicate shade of green that lurks in the imperial blaze of Sirius, the beautiful rose-red light of Aldebaran, the rich orange hue of Betelgeuse, the blue-white radiance of Rigel, and the pearly luster of Capella. If you have never seen the starry heavens except as they appear from city streets and squares, then, I had almost said, you have never seen them at all, and especially in the winter is this true. I wish I could describe to you the impression that they can make upon the opening mind of a country boy, who, knowing as yet nothing of the little great world around him, stands in the yawning silence of night and beholds the illimitably great world above him, looking deeper than thought can go into the shining vistas of the universe, and overwhelmed with the wonder of those marshaled suns.

Looking, now, at Map No. 1, we see the heavens as they appear at midnight on the 1st of December, at 10 o'clock P. M. on the 1st of January, and at 8 o'clock P. M. on the 1st of February. In the western half of the sky we recognize Andromeda, Pegasus, Pisces, Cetus, Aries,

Cassiopeia, and other constellations that we studied in the "Stars of Autumn." Far over in the east we see rising Leo, Cancer, and Hydra, which we included among the "Stars of Spring." Occupying most of the southern and eastern heavens are the constellations which we are

MAP 1.

now to describe under the name of the "Stars of Winter," because in that season they are seen under the most favorable circumstances. I have already referred to the striking manner in which the principal stars of some of these constellations are ranged round one another. By the aid of the map the observer can perceive the relative position of the different constellations, and having fixed this in his mind, he will be prepared to study them in detail.

Let us begin now with Map No. 2, which shows us the constellations of Eridanus, Lepus, Orion, and Taurus. Eridanus is a large though not very conspicuous constellation, which is generally supposed

to represent the celebrated river now known as the Po. It has had different names among different peoples, but the idea of a river, suggested by its long, winding streams of stars, has always been preserved. According to fable, it is the river into which Phaeton fell after his disastrous attempt to drive the chariot of the sun for his father Phœbus, and in which hare-brained adventure he narrowly missed burning the

MAP 2.

world up. The imaginary river starts from the brilliant star Rigel, in the left foot of Orion, and flows in a broad upward bend toward the west; then it turns in a southerly direction until it reaches the bright star Gamma (γ), where it bends sharply to the north, and then quickly sweeps off to the west once more, until it meets the group of stars marking the head of Cetus. Thence it runs south, gradually turning

eastward, and finally flowing back more than half-way to Orion, and then curving south again and disappearing beneath the horizon. Throughout this whole distance of more than 100° the course of the stream is marked by rows of stars, and can be recognized without difficulty by the amateur observer.

The first thing to do with your opera-glass, after you have fixed the general outlines of the constellation in your mind by naked eye observations, is to sweep slowly over the whole course of the stream, beginning at Rigel, and following its various wanderings. Eridanus ends in the southern hemisphere near a first-magnitude star called Achernar, which is situated in the stream, but can not be seen from our latitudes. Along the stream you will find many interesting groupings of the stars. In the map see the pair of stars below and to the right of Nu (ν). These are the two Omicrons, the upper one being o^1 and the lower one o^2. The latter is of an orange hue, and is remarkable for the speed with which it is flying through space. There are only one or two stars whose proper motion, as it is called, is more rapid than that of o^2 in Eridanus. It changes its place nearly seven minutes of arc in a century. The records of the earliest observations we possess show that near the beginning of the Christian era it was about half-way between o^1 and ν. Its companion, o^1, on the contrary, seems to be almost stationary, so that o^2 will gradually draw away from it, passing on toward the southwest until, in the course of centuries, it will become invisible from our latitudes. This flying star is accompanied by two minute companions, which in themselves form a close and very delicate double star. These two little stars, of only 9·5 and 10·5 magnitude, respectively, are, of course, beyond the ken of the observer with an opera-glass. The system of which they form a part, however, is intensely interesting, since the appearances indicate that they belong, in the manner of satellites, to o^2, and are fellow-voyagers of that wonderful star.

Having admired the star-groups of Eridanus, one of the prettiest of which is to be seen around Beta (β), let us turn next to Taurus, just above or north of Eridanus. Two remarkable clusters at once attract the eye, the Hyades, which are shaped somewhat like the letter V, with Aldebaran in the upper end of the left-hand branch, and the Pleiades, whose silvery glittering has made them celebrated in all ages. The Pleiades are in the shoulder and the Hyades in the face of Taurus, Aldebaran most appropriately representing one of his blazing eyes as he hurls himself against Orion. The constellation makers did not trouble themselves to make a complete Bull, and only the head and fore-quarters of the animal are represented. If Taurus had been completed on the scale on which he was begun there would have been no room in the sky for Aries; one of the Fishes would have had to abandon his celestial swimming-place, and even the fair Andromeda would have found herself uncomfortably situated. But as if to make

amends for neglecting to furnish their heavenly Bull with hind-quarters, the ancients gave him a most prodigious and beautiful pair of horns, which make the beholder feel alarmed for the safety of Orion. Starting out of the head above the Hyades, as illustrated in our cut, the horns curve upward and to the east, each being tipped by a bright star. Along and between the horns runs a scattered and

THE "GOLDEN HORNS" OF TAURUS.

broken stream of minute stars which seem to be gathered into knots just beyond the end of the horns, where they dip into the edge of the Milky-Way. Many of these stars can be seen, on a dark night, with an ordinary opera-glass, but to see them well, one should use as large a field-glass as he can obtain. With such a glass their appearance almost makes one suspect that Virgil had a poetic prevision of the wonders yet to be revealed by the telescope when he wrote, as rendered by Dryden, of the season—

> "When with his *golden horns* in full career
> The Bull beats down the barriers of the year."

Below the tips of the horns, and over Orion's head, there is also a rich clustering of stars, as if the Bull were flaunting shreds of sparkling raiment torn from some celestial victim of his fury. With an ordinary glass, however, the observer will not find this star-sprinkled region around the horns of Taurus as brilliant a spectacle as that presented by the Hyades and the group of stars just above them in the Bull's ear. The two stars in the tips of the horns are both interesting, each in a different way. The upper and brighter one of the two marked Beta (β) in Map No. 2, is called El Nath. It is common to the left horn of Taurus and the right foot of Auriga, who is represented standing just above. It is a singularly white star. This quality

of its light becomes conspicuous when it is looked at with a glass. The most inexperienced observer will hardly fail to be impressed by the pure whiteness of El Nath, in comparison with which he will find that many of the stars he had supposed to be white show a decided tinge of color. The star in the tip of the right, or southern horn, Zeta (ζ), is remarkable, not on its own account, but because it serves as a pointer to a famous nebula, the discovery of which led Messier to form his catalogue of nebulæ. This is sometimes called the "Crab Nebula," from the long sprays of nebulous matter which were seen surrounding it with Lord Rosse's great telescope. Our little sketch is simply intended to enable the observer to locate this strange object. If he wishes to study its appearance, he must use a powerful telescope. But with a first-rate field-glass he can see it as a speck of light in the position shown in the cut, where the large star is Zeta and the smaller ones are faint stars, the relative position of which will enable the observer to find the nebula, if he keeps in mind that the top of the cut is toward the north. It is noteworthy that this nebula for a time deceived several of the watchers who were on the lookout for the predicted return of Halley's comet in 1835.

THE CRAB NEBULA.

And now let us look at the Hyades, an assemblage of stars not less beautiful than their more celebrated sisters the Pleiades. The leader of the Hyades is Aldebaran, or Alpha Tauri, and his followers are worthy of their leader. The inexperienced observer is certain to be surprised by the display of stars which an opera-glass brings to view in the Hyades. Our illustration will give some notion of their appearance with a large field-glass. The "brackish poet," of whose rhymes Admiral Smyth was so fond, thus describes the Hyades:

> "In lustrous dignity aloft see Alpha Tauri shine,
> The splendid zone he decorates attests the Power divine:
> For mark around what glitt'ring orbs attract the wandering eye,
> You'll soon confess no other star has such attendants nigh."

The redness of the light of Aldebaran is a very interesting phenomenon. Careful observation detects a decided difference between its color and that of Betelgeuse, or Alpha Orionis, which is also a red star. It differs, too, from the brilliant red star of summer, Antares. Aldebaran has a trace of rose color in its light, while Betelgeuse is of a very deep orange, and Antares may be described as fire-red. These shades of color can easily be detected by the naked eye after a little practice. First compare Aldebaran and Betelgeuse, and glance from each to the brilliant white, or bluish-white, star Rigel in Orion's foot.

Upon turning the eye back from Rigel to Aldebaran the peculiar color of the latter is readily perceived. Spectroscopic analysis has revealed the presence in Aldebaran of hydrogen, sodium, magnesium, calcium, iron, bismuth, tellurium, antimony, and mercury. And so modern discoveries, while they have pushed back the stars to distances of which the ancients could not conceive, have, at the same time, and equally, widened the boundaries of the physical universe and abolished forever the ancient distinction between the heavens and the earth. It is a plain road from the earth to the stars, though mortal feet can not tread it.

Keeping in mind that in our little picture of the Hyades the top is north, the right hand west, and left hand east, the reader will be able to identify the principal stars in the group. Aldebaran is readily recognized, because it is the largest of all. The bright star near the upper edge of the picture is Epsilon Tauri, and its sister star, forming the point of the V, is Gamma Tauri. The three brightest stars between Epsilon and Gamma, forming a little group, are the Deltas, while the pair of stars surrounded by many smaller ones, halfway between Aldebaran and Gamma, are the Thetas. These stars present a very pretty appearance, viewed with a good glass, the effect being heightened by a contrast of color in the two Thetas. The little pair southeast of Aldebaran, called the Sigmas, is also a beautiful object. The distance apart of these stars is about seven minutes of arc, while the distance between the two Thetas is about five and a half minutes of arc. These measures may be useful to the reader in estimating the distances between other stars that he may observe. It will also be found an interesting test of the eye-sight to endeavor to see these stars as doubles with the unaided eye. Persons having keen eyes will be able to do this.

THE HYADES.

North of the star Epsilon will be seen a little group in the ear of the Bull (see cut, "The Golden Horns of Taurus"), which presents a brilliant appearance with a small glass. The southernmost pair in the group are the Kappas, whose distance apart is very nearly the same

as that of the Thetas, described above; but I think it improbable that anybody could separate them with the naked eye, as there is a full magnitude between them in brightness, and the smaller star is only of magnitude 6·5, while sixth-magnitude stars are generally reckoned as the smallest that can be seen by the naked eye. Above the Kappas, and in the same group in the ear, are the two Upsilons, forming a wider pair.

Next we come to the Pleiades.

"Though small their size and pale their light, wide is their fame."

In every age and in every country the Pleiades have been watched, admired, and wondered at, for they are visible from every inhabited land on the globe. To many they are popularly known as the Seven Stars, although few persons can see more than six stars in the group with the unaided eye. It is a singular fact that many of the earliest writers declare that only six Pleiades can be seen, although they all assert that they are seven in number. These seven were the fabled daughters of Atlas, or the Atlantides, whose names were Merope, Alcyone, Celæno, Electra, Taygeta, Asterope, and Maia. One of the stories connected with them is that Merope married a mortal, whereupon her star grew dim among her sisters. Another fable assures us that Electra, unable to endure the sight of the burning of Troy, hid her face in her hands, and so blotted her star from the sky. While we may smile at these stories, we can not entirely disregard them, for they are intermingled with some of the richest literary treasures of the world, and they come to us, like some old keepsake, fragrant with the perfume of a past age. The mythological history of the Pleiades is intensely interesting, too, because it is world wide. They have impressed their mark, in one way or another, upon the habits, customs, traditions, language, and history of probably every nation. This is true of savage tribes as well as of great empires. The Pleiades furnish one of the principal links that appear to connect the beginnings of human history with that wonderful prehistoric past, where, as through a gulf of mist, we seem to perceive faintly the glow of a golden age beyond. The connection of the Pleiades with traditions of the Flood is most remarkable. In almost every part of the world, and in various ages, the celebration of a feast or festival of the dead, dimly connected by tradition with some great calamity to the human race in the past, has been found to be directly related to the Pleiades. This festival or rite, which has been discovered in various forms among the ancient Hindoos, Egyptians, Persians, Peruvians, Mexicans, Druids, etc., occurs always in the month of November, and is regulated by the culmination of the Pleiades. The Egyptians directly connected this celebration with a deluge, and the Mexicans, at the time of the Spanish conquest, had a tradition that the world had once been destroyed at the time of the midnight culmination of the Pleiades. Among the

savages inhabiting Australia and the Pacific island groups a similar rite has been discovered. It has also been suggested that the Japanese feast of lanterns is not improbably related to this world-wide observance of the Pleiades, as commemorating some calamitous event in the far past which involved the whole race of man in its effects.

THE PLEIADES.

The Pleiades also have a supposed connection with that mystery of mysteries, the great Pyramid of Cheops. It has been found that about the year 2170 B. C., when the beginning of spring coincided with the culmination of the Pleiades at midnight, that wonderful group of stars was visible, just at midnight, through the mysterious southward-pointing passage of the Pyramid. At the same date the then pole-star, Alpha Draconis, was visible through the northward-pointing passage of the Pyramid.

Another curious myth involving the Pleiades as a part of the constellation Taurus is that which represents this constellation as the Bull into which Jupiter changed himself when he carried the fair Europa away from Phœnicia to the continent that now bears her name. In this story the fact that only the head and fore-quarters of the Bull are visible in the sky is accounted for on the ground that the remainder of his body is beneath the water through which he is swimming. Here, then, is another apparent link with the legends of the Flood, with which the Pleiades have been so strangely connected, as by common consent among so many nations, and in the most widely-separated parts of the earth.

With the most powerful field-glass you may be able to see all of the stars represented in our picture of the Pleiades. With an ordinary opera-glass the fainter ones will not be visible; yet even with such a glass the scene is a remarkable one. Not only all of the "Seven Sisters," but many other stars can be seen twinkling among them. The superiority of Alcyone to the others, which is not so clear to the naked eye, becomes very apparent. Alcyone is the large star below the middle of the picture with a triangle of little stars beside it. To the left or east of Alcyone the two most conspicuous stars are Atlas and Pleione. The latter—which is the uppermost one—is rep-

resented too large in the picture. It requires a sharp eye to see Pleione without a glass, while Atlas is plainly visible to the unaided vision, and is always counted among the naked-eye Pleiades, although it does not bear the name of one of the mythological sisters, but that of their father. The bright star below and to the right of Alcyone is Merope; the one near the right-hand edge of the picture, about on a level with Alcyone, is Electra. Above, or to the north of Electra, are two bright stars lying in a line pointing toward Alcyone; the upper one of these, or the one farthest from Alcyone, is Taygeta, and the other is Maia. Above Taygeta and Maia, and forming a little triangle with them, is a pair of stars which bears the name of Asterope. About half-way between Taygeta and Electra, and directly above the latter is Celæno.

The naked-eye observer will probably find it difficult to decide which he can detect the more easily, Celæno or Pleione, while he will discover that Asterope, although composed of two stars, as seen with a glass, is so faint as to be much more difficult than either Celæno or Pleione. Unless, as is not improbable, the names have become interchanged in the course of centuries, the brightness of these stars would seem to have undergone remarkable changes. The star of Merope, it will be remembered, was fabled to have become faint, or disappeared, because she married a mortal. At present Merope is one of those that can be plainly seen with the naked eye, while the star of Asterope, who was said to have had the god Mars for her spouse, has faded away until only a glass can show it. It would appear, then, that notwithstanding an occasional temporary eclipse, it is, in the long run, better to marry a plain mortal than a god—or a lord. Electra, too, who hid her fair eyes at the sight of burning Troy, seems to have recovered from her fright, and at present is, next to Alcyone, the brightest star in the cluster. But however we may regard those changes in the brightness of the Pleiades which are based upon tradition, there is no doubt that well-attested changes have taken place in the comparative brilliancy of stars in this cluster since astronomy has become an exact science.

Observations of the proper motions of the Pleiades have shown that there is an actual physical connection between them; that they are, literally speaking, a flight of suns. Their common motion is toward the southwest under the impulse of forces that remain as yet beyond the grasp of human knowledge. Alcyone was selected by Mädler as the central sun around which the whole starry system revolved, but later investigations have shown that his speculation was not well founded, and that, so far as we can determine, the proper motions of the stars are not such as to indicate the existence of any common center. They appear to be flying with different velocities in every direction, although—as in the case of the Pleiades—we often find groups of them associated together in a common direction of flight.

Still another curious fact about the Pleiades, is the existence of some rather mysterious nebulous masses in the cluster. In 1859, Temple discovered an extensive nebula, of an oval form, nearly egg-shaped, with the star Merope immersed in one end of it. Subsequent observations showed that this strange phenomenon was variable. Sometimes it could not be seen; at other times it was very plain and large. In Jeaurat's chart of the Pleiades, made in 1779, a vast nebulous mass is represented near the stars Atlas and Pleione. This has since been identified by Goldschmidt as part of a huge, ill-defined nebula, which he thought he could perceive enveloping the whole group of the Pleiades. Many observers, however, could never see these nebulous masses, and were inclined to doubt their actual existence. Within the past few years astronomical photography, having made astonishing progress, has thrown new light upon this mysterious subject. The sensitized plate of the camera, when applied at the focus of a properly-constructed telescope, has proved more effective than the human retina, and has, so to speak, enabled us to see beyond the reach of vision by means of the pictures it makes of objects which escape the eye. In November, 1885, Paul and Prosper Henry turned their great photographing telescope upon the Pleiades, and with it discovered a nebula apparently attached to the star Maia. The most powerful telescopes in the world had never revealed this to the eye. Yet of its actual existence there can be no question. Their photograph also showed the Merope nebula, although much smaller, and of a different form from that represented by its discoverer and others. There evidently yet remains much to be discovered in this singular group, and the mingling of nebulous matter with its stars makes Tennyson's picturesque description of the Pleiades appear all the more life-like:

"Many a night I saw the Pleiads, rising through the mellow shade
Glitter like *a swarm of fire-flies tangled in a silver braid.*"

The reader should not expect to be able to see the nebulæ in the Pleiades with an opera-glass. I have thought it proper to mention these nebulous objects only in order that he might be in possession of the principal and most curious facts about those interesting stars.

Orion will next command our attention. You will find the constellation in Map No. 2.

"Eastward beyond the region of the Bull
Stands great Orion; whoso kens not him in cloudless night
Gleaming aloft, shall cast his eyes in vain
To find a brighter sign in all the heaven."

To the naked eye, to the opera-glass, and to the telescope, Orion is alike a mine of wonders. This great constellation embraces almost every variety of interesting phenomena that the heavens contain. Here we have the grandest of the nebulæ, some of the largest and most beautifully-colored stars, star-streams, star-clusters, nebulous stars,

variable stars. I have already mentioned the positions of the principal stars in the imaginary figure of the great hunter. I may add that his upraised right arm and club are represented by the stars seen in the map above Alpha (α) or Betelgeuse, one of which is marked Nu (ν) and another, in the knob of the club, Chi (χ). I have also, in speaking of Aldebaran, described the contrast in the colors of Betelgeuse and Beta (β) or Rigel. Betelgeuse, it may be remarked, is slightly variable. Sometimes it appears brighter than Rigel, and sometimes less brilliant. It is interesting to note that according to Secchi's division of the stars into types, based upon their spectra, Betelgeuse falls into the third order, which seems to represent a type of suns in which the process of cooling, and the formation of an absorptive envelope or shell have gone on so far that we may regard them as approaching the point of extinction. Rigel, on the other hand, belongs to the first order or type which represents suns that are probably both hotter and younger in the order of development. So, then, we may look upon the two chief stars of this great constellation as representing two stages of cosmical existence. Betelgeuse shows us a sun that has almost run its course, that has passed into its decline, and that already begins to faint and flicker and grow dim before the on-coming and inevitable fate of extinction; but in Rigel we see a sun blazing with the fires of youth, splendid in the first glow of its solar energies, and holding the promise of the future yet before it. Rigel belongs to a new generation of the universe; Betelgeuse to the universe that is passing. We may pursue this comparison one step farther back and see in the great nebula, which glows dimly in the middle of the constellation, between Rigel triumphant and Betelgeuse languishing, a still earlier cosmical condition—the germ of suns whose infant rays may illuminate space when Rigel itself is growing dim.

THE SWORD OF ORION AND THE GREAT NEBULA.

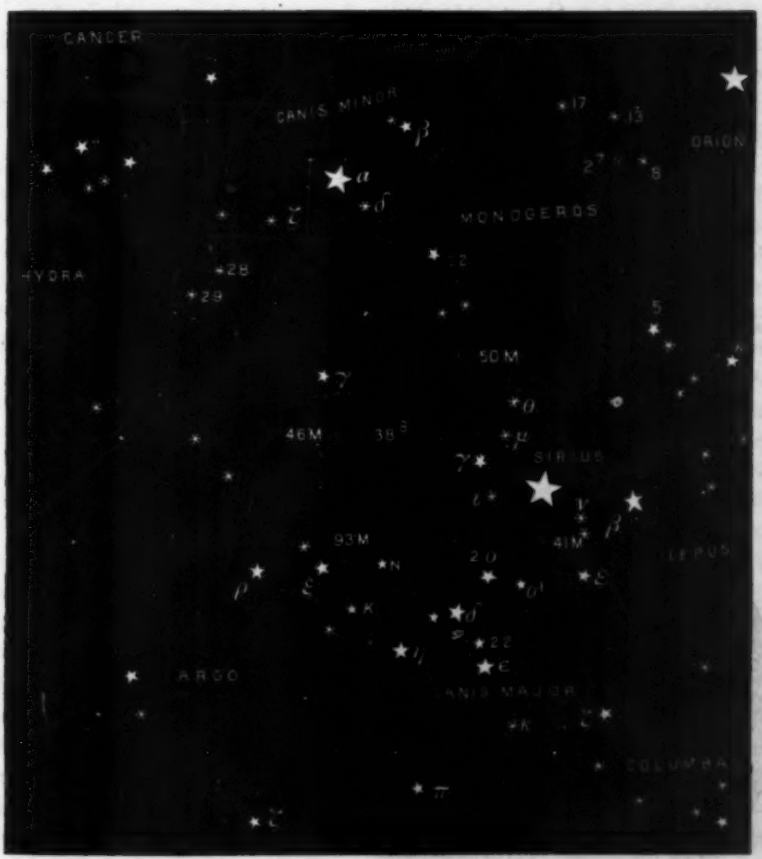
Turn your glass upon the three stars forming the Belt. You will not be likely to undertake to count all the twinkling lights that you will see, especially as many of them appear and disappear as you turn your attention to different parts of the field. Sweep all around the Belt and also between the Belt and Gamma (γ) or Bellatrix. According to the old astrologers, women born under the influence of the star Bellatrix were lucky, and provided with good tongues. Of course this was fortunate for their husbands.

Below the belt will be seen a short row of stars hanging downward

and representing the sword. In the middle of this row is the great Orion nebula. The star Theta (θ) involved in the nebula is multiple and the position of this little cluster of suns is such that, as has been said, they seem to be feeding upon the substance of the nebula surrounding them. Other stars are seen scattered in different parts of the nebula. This phenomenon can be plainly seen with an opera-glass. Our picture of the Sword of Orion shows its appearance with a good field-glass. With such a glass several fine test-objects will be found in the Sword. One of the best of these is formed by the two five-pointed stars seen in the picture close together above the nebula. No difficulty will be encountered in separating these stars with a field-glass, but it will require a little sharp watching to detect the small star between the two and just above the line joining them. So, the bending row of faint stars above and to the right of the group just described will be found rather elusive as individuals, though easily glimpsed as a whole. Of the great nebula itself not much detail can be seen. Yet by averting the eyes the extension of the nebulous light in every direction from the center can be detected and traced, under favorable circumstances, to a considerable distance. The changes that this nebula has certainly undergone in the brilliancy, if not in the form, of different parts of it, are perhaps indications of the operation of forces, which we know must prevail there, and whose tendency can only be in the direction of condensation, and the ultimate formation of future suns and worlds. Yet, as the appearance of the nebula in great telescopes shows, we can not expect that the processes of creation will here produce a homologue of our solar system. The curdled appearance of the nebula indicates the formation of various centers of condensation the final result of which will doubtless be a group of stars like some of those which we see in the heavens, and whose common motion shows that they are bound together in the chains of reciprocal gravitation. The Pleiades are an example of such a group.

Do not fail to look for a little star just west of Rigel, and which, with a good opera-glass, appears to be almost hidden in the flashing rays of its brilliant companion. If you have also a field-glass, after you have detected this shy little twinkler with your opera-glass, try the larger glass upon it. You will find then that the little star originally seen is not the only one there. A still smaller star, which had before been completely hidden, will now be perceived. I may add that, with telescopes, Rigel is one of the most beautiful double stars in the sky, having a little blue companion close under its wing. Run your glass along the line of little stars forming the lion's skin or shield that Orion opposes to the onset of Taurus. Here you will find some interesting combinations, and the star marked on the map π^5 will especially attract your eye, because it is accompanied, about fifteen minutes to the northwest, by a seventh-magnitude star of a remarkably rich orange hue.

Look next at the little group of three stars forming the head of Orion. Although there is no nebula here, yet these stars, as seen with the naked eye, have a remarkably nebulous look, and Ptolemy regarded the group as a nebulous star. The largest star is called Lambda (λ); the others are Phi (ϕ) one and two. An opera-glass will show another star above λ, and a fifth star below ϕ^2, which is the farthest of the two Phis from Lambda. It will also reveal a faint twinkling between λ and ϕ^1. A field-glass shows that this twinkling is produced by a pretty little row of three stars of the eighth and ninth magnitudes.



MAP 2.

In fact, Orion is such a striking object in the sky that more than one attempt has been made to steal away its name and substitute that of some modern hero. The University of Leipsic, in 1807, formally resolved that the stars forming the Belt and Sword of Orion should henceforth be known as the constellation of Napoleon. A more ridiculous proposition was that of an Englishman, who proposed to rename Orion for the British naval bull-dog Nelson.

The little constellations of Lepus and Columba, below Orion, need not detain us long. You will find in them some pretty combinations of stars. In Lepus is the celebrated "Crimson Star," which has been described as resembling a drop of blood in color—a truly marvelous hue for a sun—but, as it is never brighter than the sixth magnitude, and from that varies down to the ninth, we could hardly hope to see its color well with an opera-glass. Besides, the observer would have difficulty in finding it.

We will now turn to the constellation of Canis Major, represented in Map No. 3. Although, as a constellation, it is not to be compared with the brilliant Orion, yet, on account of the unrivaled magnificence of its chief star, Canis Major presents almost as attractive a scene as its more extensive rival. Everybody has heard of Sirius, or the Dog-Star, and everybody must have seen it flashing and scintillating so splendidly in the winter heavens, that to call it a first-magnitude star does it injustice, since no other star of that magnitude is at all comparable with it. Sirius, in fact, stands in a class by itself as the brightest star in the sky. Its light is white with a shade of green which requires close watching to be detected. When it is near the horizon, or when the atmosphere is very unsteady, Sirius flashes prismatic colors like a great diamond. The question has been much discussed as to whether Sirius was not formerly a red star. It is described as red by several ancient authors, but it seems to be pretty well established that these descriptions are most of them due to a blunder made by Cicero in his translation of the astronomical poem of Aratus. It is not impossible, though it is highly improbable, that Sirius has changed color.

DELTA ORIONIS AND ITS NEIGHBORS.

Your eyes will be fairly dazzled when you turn your glass upon this splendid star. By close attention you will be able to perceive a number of faint stars, mere points by comparison, in the immediate neighborhood of Sirius. There are many interesting objects in the constellation. The star marked Nu (ν) in the map, is really triple, as the smallest glass will show. Look next at the star-group 41 M. The cloud of minute stars of which it is composed can be very well seen with a field-glass or a powerful opera-glass. The star 22 is of a very ruddy color that contrasts beautifully with the light of Epsilon (ϵ), which can be seen in the same field of view with an opera-glass.

Between the stars Delta (δ) and o^1 and o^2 there is a remarkable array of minute stars, as shown in the accompanying cut. One never sees stars arranged in streams or rows, like these, without an irresistible impression that the arrangement can not be accidental; that some law must have been in operation which associated them together in the forms which we see. Yet, when we reflect that these are all suns, how far do we seem to be from understanding the meaning of the universe.

The extraordinary size and brilliancy of Sirius might naturally enough lead one to suppose that it is the nearest of the stars, and such it was once believed to be. Observations of stellar parallax, however, show that this was a mistake. The distance of Sirius is so great that no satisfactory determination of it has yet been made. We may safely say, though, that that distance is, at the least calculation, 50,000,000,000,000 miles. In other words, Sirius is about 537,000 times as far from the earth as the sun is. Then since light diminishes as the square of the distance increases, the sun, if placed as far from us as Sirius is, would send us, in round numbers, 288,000,000,000 times less light than we now receive from it. But Sirius actually sends us only about 4,000,000,000 times less light than the sun does; consequently Sirius must shine $\frac{288,000,000,000}{4,000,000,000} = 72$ times as brilliantly as the sun. If we adopt Wollaston's estimate of the light of Sirius, as compared with that of the sun's, viz., $\frac{1}{20,000,000,000}$, we shall still find that the actual brilliancy of that grand star is more than fourteen times as great as that of our sun. But as observations on the companion of Sirius show that Sirius's mass is fully twenty times the sun's, and since the character of Sirius's spectrum indicates that its intrinsic brightness, surface for surface, is much superior to the sun's, it is probable that our estimate of the star's actual brilliancy, as compared with what the sun would possess at the same distance, viz., seventy-two times, is much nearer the truth. It is evident that life would be insupportable upon the earth if it were placed as near to Sirius as it is to the sun. If the earth were a planet belonging to the system of Sirius, in order to enjoy the same amount of heat and light it now receives, it would have to be removed to a distance of nearly 800,000,000 miles, or about $8\frac{1}{2}$ times its distance from the sun. Its time of revolution around Sirius would then be nearly $5\frac{1}{2}$ years, or, in other words, the year would be lengthened $5\frac{1}{2}$ times.

But, as I have said, the estimate of Sirius's distance used in these calculations is the smallest that can be accepted. Good authorities regard the distance as being not less than 100,000,000,000,000 miles; in which case the star's brilliancy must be as much as 228 times greater than that of the sun! And yet even Sirius is probably not the greatest sun belonging to the visible universe. There can be little doubt that Canopus, in the southern hemisphere, is a grander sun than Sirius.

To our eyes, Canopus is only about half as bright as Sirius, and it ranks as the second star in the heavens in the order of brightness. But while Sirius's distance is measurable, that of Canopus is so unthinkably immense that astronomers can get no grip upon it. If it were only twice as remote as Sirius it would be equal to two of the latter, but the probability is its distance is much greater than that. And possibly even Canopus is not the greatest gem in the coronet of creation.

East and south of Canis Major, which, by the way, is fabled to represent one of Orion's hounds, is part of the constellation Argo, which stands for the ship in which Jason sailed in search of the golden fleece. The observer will find many objects of interest here, although some of them are so close to the horizon in our latitudes that much of their brilliancy is lost. Note the two stars ζ and π near the lower edge of the map, then sweep slowly over the space lying between them. About half-way your attention will be arrested by a remarkable arrangement of stars, in which a beautiful half-circle of small stars curving above a larger one, which is reddish in color, is conspicuous. This neighborhood will be found rich in stars that the naked eye can not see. Just below the star η in Canis Majoris is another fine group. The star π, which is deep yellow or orange, has three little stars above it, two of which form a pretty pair. The star ξ has a companion, which forms a fine test for an opera-glass, and is well worth looking for. Look also at the cluster 93 M, just above and to the west of ξ. The stars η and κ are seen double with an opera-glass.

The two neighboring clusters, 46 M and 38^8, are very interesting objects. To see them well, use a powerful field-glass. A "fiery fifth-magnitude star," as Webb calls it, can be seen in the field at the same time. The presence of the Milky-Way is manifest by the sprinkling of stars all about this region.

Turning now to the constellation Monoceros, we shall find a few objects worthy of attention. This constellation is of comparatively modern origin, having been formed by Bartschius, whose chief title to distinction is that he married the daughter of John Kepler. The region around the stars 8, 13, and 17 will be found particularly rich, and the cluster 2^7 shows well with a strong glass. Look also at the cluster 50 M, and compare its appearance with that of the clusters in Argo.

With these constellations we finish our review of the celestial wonders that lie within the reach of so humble an instrument as an opera- or field-glass. We have made the circuit of the sky, and the hosts that illumine the vernal heavens are now seen advancing from the east, and pressing close upon the brighter squadrons of winter. Their familiar figures resemble the faces of old friends whom we are glad to welcome. These starry acquaintances never grow wearisome. Their interest for us is as fathomless as the deeps of space in which they shine. The man never yet lived whose mind could comprehend the full meaning of the wondrous messages that they flash to us upon the

wings of light. As we watch them in their courses, the true music of the spheres comes to our listening ears, the chorus of creation—faint with distance, for it is by slow approaches that man draws near to it—chanting the grandest of epics, the Poem of the Universe; and the theme that runs through it all is the reign of law. Do not be afraid to become a star-gazer. The human mind can find no higher exercise. He who studies the stars will discover—

> "An endless fountain of immortal drink
> Pouring unto us from heaven's brink."

THE ADULTERATION OF MILK.

By Professor C. HANFORD HENDERSON.

THE absolute necessity of maintaining a certain standard of purity in food-products, has led, in most of the States, to a comprehensive and somewhat stringent legislation concerning adulteration. Particularly is this the case as regards the products of the dairy. The official inspection busies itself with both the qualitative and quantitative value of these articles. Of all the foods supplied directly by Nature, milk is the only one which contains all the elements of nutrition in the relative proportions required by man, and in a form easy of digestion; it is therefore the food best suited to young children and invalids—persons who can ill afford to have their food tampered with in any way. This consideration, together with the universal use of the article, has determined the adoption of a system of public inspection in nearly all of our larger cities. The States of Massachusetts, New York, and Michigan have given particular attention to the honesty of the milkman, and the standards of quality and methods of analysis established by their public analysts have been generally adopted by chemists all over the country. Yet, in spite of the vigilant eye which is thus constantly watching this department of the farm, pounds of butter weighed according to a system of units not recognized in the arithmetics, milk which contains an abnormal percentage of water, and cream whose composition will not bear investigation, are daily sold in the market-places of both city and country.

But there are, of course, two sides to the question. Not unfrequently the milkman is accused entirely without cause. There are few housekeepers who do not sincerely believe, in spite of an otherwise general faith in mankind, that he, at least, will bear watching. The analyst, however, is a perfectly unprejudiced person. He cares little for the protestations of the vender, or the suspicions of the customer. He simply says, "Your milk should have such and such a specific gravity; it should contain such and such percentages of fat, of other hydrocarbons, of mineral salts, and of water: if it contain

these, it is an honest milk; if it do not, it is adulterated." And generally, the analyst is not open to argument. He has implicit faith in his hydrometer and analytical balance.

It is the purpose of the present article to point out the adulterants which are commonly found in milk, and to describe a simple method of analysis which will give conclusive results even when practiced by those having no great proficiency in the use of apparatus and reagents. The complete chemical analysis of a sample of milk is an operation which taxes the patience of even a trained chemist, and when accomplished, it has little value not possessed by the results obtained from the more rapid methods used by the State analysts. It is commonly believed that the list of adulterants at the disposal of the dairyman is practically unlimited, but if one will pause a moment, and reflect that the adulterant chosen must not affect the taste of the milk, or show any tell-tale sediment on standing, he will see that the possibilities of fraud are much smaller than at first suspected. Of all the adulterants, water is the most popular the land over, since it costs nothing and tells no tales unless questioned by an analyst. In addition to water, it is not uncommon to find a milk "doctored" by the use of preservative salts, such as borax or bicarbonate of soda, and colored to an ideal cream tint by means of a little burnt sugar or vegetable coloring-matter.

In the State laboratories, it is generally required that determinations shall be made of the specific gravity, the amount of cream, total solids, fat, mineral salts, and water. Mr. Sharples, public analyst for Massachusetts, recommends also the determination of the amount of sugar in the milk in order to place its quality beyond peradventure. Most analysts, however, do not regard this determination as necessary. As it is our object to make the analytical process as simple as possible, and to bring it within reach of all readers having some delicacy of touch, whether they be chemists or not, we shall only describe those determinations generally considered essential, and then specify which of these will suffice in most cases to establish the quality of the sample under consideration.

The first requisite is to decide upon a standard of purity. Opinions differ as to what should be considered a normal milk. The chief discrepancy lies in the amount of total solids which it should contain. In England the standard in this respect is rather low, only 11·5 per cent of total solids being required. In Massachusetts, on the other hand, the legal standard exceeds even the generosity of Nature, as it calls for 13 per cent, when milk drawn directly from the cow, and therefore free from any possibility of dilution, frequently shows but a little over 12.

The following abbreviated table will give the composition of average milk, and will serve as a standard for comparison when the results of any particular analysis have been obtained:

Specific gravity	1·03
Total solids	12·50
Fat	3·20
Organic solids not fat	8·70
Mineral salts	·60
Water	87·50

The sample of milk selected for examination should be quite fresh, but never warm. The temperature should be about 60° F.

Of the several determinations required, that of specific gravity is at once the easiest and the most important. It is made either by means of the specific-gravity bottle or the hydrometer.

The specific-gravity bottle is a small glass flask which will contain a given weight of distilled water. The form used by the writer is shown in Fig. 1. It is adjusted to fifty grammes of water, and is accompanied by a small brass weight to exactly counterpoise the weight of the flask. To determine the specific gravity of a sample of milk the bottle is completely filled with the milk and the stopper brought into contact with the fluid, care being taken that no air adheres to its under side. The stopper is then permitted to fall quickly into its bearing in the neck of the bottle. The excess of milk escapes through the fine perforation in the stopper. In this way an invariable volume of fluid is always weighed. The flask is then carefully wiped off, and the whole weighed, remembering, of course, to add the counterpoise weight to the scale-pan, in order to allow for the weight of the flask. The weight of the milk is obtained in grammes, and this multiplied by ·02 will give its specific gravity directly.

Fig. 1.—Fifty-Gramme Specific-Gravity Bottle.

By the use of the hydrometer (or lactometer, as it is usually called, when graduated for milk), the determination of the specific gravity may be made much more rapidly. A convenient form of this instrument is shown in Fig. 2. It will require no explanation beyond brief mention of the system of marking employed. The upper graduation on the stem of the tube is marked 1, and is the point to which the instrument will sink when placed in pure, distilled water, at 60° F. The lower graduation is marked 1·05, and is the point to which the instrument will sink when placed in a fluid of that specific gravity. As normal milk averages 1·03, the variations on either side will be fully covered by these limits. A low specific gravity indicates that the

pump has been called into requisition, while a high specific gravity indicates a deficiency in cream. A popular form of lactometer, showing directly the proportion of water added to the sample, may be purchased of dealers in chemical apparatus for seventy-five cents, but some care must be exercised in its selection, since one instrument now offered the public has the point marked "skim milk" *above* that marked "pure milk." Evidently it should be *below*, as skimmed milk has a greater specific gravity than whole milk.

FIG. 2.—LACTOMETER WITH DIRECT GRADUATION.

In some States the test of specific gravity by the lactometer is the only determination made. In spite of the importance of the test, however, it is not always conclusive. A very rich milk will show a suspiciously low specific gravity, while a skimmed milk, diluted with water to the proper density and colored to an agreeable cream-tint by "Richardson's Perfected Butter Color" or other dye, will escape so much as the breath of scandal.

The amount of cream is generally determined by permitting the sample to stand in a graduated jar until the cream separates, and then reading off the volume percentage directly. Centrifugal machines are also used, but a simpler test than either of these is usually sufficient. If a closed tube, blackened on the inside, is dipped into the sample, and slowly withdrawn, one can judge of the richness of the milk by the opacity of the film remaining on the tube.

To determine the total solids, five cubic centimetres of the sample of milk are placed in a small platinum dish of known weight, and the joint weight of milk and dish then obtained. The difference between the two will be the amount of milk taken for analysis. It is then evaporated to dryness on a water-bath without stirring. This will take about an hour, at the end of which time the dish will be found to contain a yellowish-white mass which shows a thin, transparent film on top and a honeycombed structure beneath. A number of cracks will extend throughout the mass, on account of the contraction on drying, but do not indicate that anything is amiss. The dish and contents are then put into an oven at 212° F., and at the end of half an hour are taken out and weighed. The known weight of the dish subtracted from the weight thus obtained gives the weight of the total solids. The ratio of this weight to the weight of milk taken for analysis will give the percentage value.

If it be desired to find the amount of fat, petroleum-benzine is poured over the residue and is renewed at the end of an hour. After standing half an hour longer, the solvent is again decanted. The residue is thoroughly washed with benzine, and is dried in an oven at

212° F., in order to remove all traces of the fluid. The loss of weight experienced as the result of this treatment equals the amount of fat.

The amount of mineral salts is determined by igniting the residue until it is perfectly white. The heat must be very gradually increased in order to avoid loss from sputtering. The ash is then directly weighed, and its percentage value obtained as in the case of the total solids, that is, by the ratio of its weight to the amount of milk originally taken. The water is readily found by subtracting the per cent of total solids from 100.

The operations described above are all very easily made, and require comparatively but a short time. They presuppose, of course, the employment of a certain amount of apparatus, but if one can depend upon the courtesy of some chemical or pharmaceutical friend for the use of an analytical balance, all of the other requirements can be met at no very great expense. An analysis such as has been outlined, will show conclusively the quality of any suspected sample of milk, for the milk will deviate from the normal condition just in proportion as its constituents differ from those of the standard given. If, for instance, it is found that the specific gravity and percentage of total solids are both low, the addition of water is plainly indicated. By calculating the amount of whole milk corresponding to the total solids found, it is possible to state just how much water has been added. When it is found that the specific gravity is as it should be, and the total solids are between 12 and 12·5 per cent, it is seldom worth while to continue the analysis further than a determination of the mineral salts, for it would scarcely be possible for these three quantities to be what they should be unless the milk were quite normal. Thus, in a sample of milk recently analyzed by the writer, the specific gravity was found to be 1·033, the total solids 12·077 per cent, the mineral salts 0·598 per cent, and the water 87·923 per cent. Though the solid constituents were somewhat low, the discrepancy was too slight to fancy for a moment that the milk had been tampered with in any way.

Occasionally chalk or lime-water is added to give body to a diluted milk. Its presence will be readily detected by the increased amount of ash, which may be examined by the well-known qualitative methods. During the warmer months, the difficulties of keeping milk fresh not infrequently lead to the addition of bicarbonate of soda or borax, but as a preservative the latter salt is an absolute failure. It simply keeps the curd from precipitating, but does not prevent the decomposition of the milk. After standing some time such a milk will be found to emit a very putrid, disagreeable odor.

Though the addition of these adulterants is far from commendable on the part of the milkman, the reflection is not without comfort that they exercise for the most part no injurious influence on the animal economy—a reflection, by the way, which can not be indulged in about the majority of food adulterants.

RECENT VIEWS RESPECTING CANCER.

By ROBERT T. MORRIS, M.D.

WHEN one of the gall-flies (*cynips*) stings the tender shoot of a rose-bush, the poison which is deposited along with her eggs excites at that portion of the twig an excessive degree of nutrition, and the resulting swelling becomes the home of the young of the fly.

The rose-bush gall is composed of nothing more than ordinary vegetable tissues; but they are abnormally developed, and there is an accompanying modification in the growth of normal structures. For instance, the vegetable hairs at that point may increase in size until they resemble large thorns, and an involved leaflet may lose its identity and become a part of the tumor. The color-grains (*chlorophyll*), which should give to the bark a green color, may show various shades of red instead. The rose-gall is not very different from the morbid growths of animal tissues which appear as tumors of various kinds; and we know that some, and presume that many, of the latter, are due to the disturbance caused by the presence of humble parasites belonging to the vegetable world. These parasites, or microbes, as they are called, are so small that it is impossible at present to study the life-histories of some of the species. No one has satisfactorily described any specific cancer-producing microbe, but it was only yesterday that we became acquainted with the cousins which cause the development of the tumors of glanders, of tuberculosis, of carbuncle, and of "big-head" (*actinomycosis*)—so that, reasoning by analogy, it seems more than probable that all malignant growths belong to the infectious microbic diseases, and that by to-morrow we shall have the tiny causators in a position in which they can be examined.

The malignant tumors of warm-blooded vertebrate animals are divided into two great classes—the sarcomas and the cancers. These growths are like the galls of various plants, in that they are composed not of new tissues, but of abnormally arranged tissues of ordinary character. Structures in their vicinity lose caste and become merged into tissue of some one type, just as the leaflet gives up its position as a lung for the rose and helps to build a house for the young gall-flies.

We have in cancer a sort of anarchy of cells, as it were, in which the leaders, whose work, for instance, consisted in the construction of muscle, are routed from their high positions and forced to become common members of a low organization.

Like many popular names the term cancer is indefinite, but it is principally used to distinguish three or four forms of malignant growth from the sarcomas and from benign tumors. The benign tumors grow within limiting capsules; pushing other tissues out of the way as they increase in size, and showing no tendency to affect the

blood or to appear secondarily at different places in the body of the same patient. The malignant tumors, on the other hand, are those which are not limited by a capsule. They reach out and involve all kinds of tissue which happen to be near them; they infect the blood, and new colonies form at points situated at a distance from the parent growth. There is hardly a doubt but that malignant growths are quite local at the outset, but, like red ants, the microbes make more and more nests in the same field. As with red ants, too, we often fail to eradicate the colony, because many members may be away from home at the time when the nests are destroyed.

Malignant tumors have been produced in the dog by inoculation from an infected dog, in the horse by inoculation from the dog, and the horse has been inoculated from the horse. We are afraid that cancer is inoculable between animals and man, and between man and man, but on this point medical literature at present furnishes little reliable testimony.

Why it is that the cancer microbes which enter a cut on the surgeon's finger do not regularly produce cancer in the surgeon is a fact not easily explained. It is, however, a well-known fact, that certain other species of microbes are very particular about sites for their homes, and we may suppose that the cancer microbe finds a suitable field for growth in a relatively small number of persons.

When a malignant tumor is developing at any one point the lymphatic vessels in the vicinity are involved at an early date, and they eventually serve as channels for the passage of the disease into the blood.

If a far advanced primary growth of cancer could be stained in its entirety with a black dye, and if the patient were transparent, we should probably see that the tissues round about the growth were dusky, and that a thin, smoky coloring extended through the lymphatic vessels to the veins into which they empty. As a malignant tumor increases in size at its original situation the nerve filaments are pinched, and pain is caused as a rule; but sometimes the growth will progress with little or no accompanying pain.

When an operation by a competent surgeon is performed during the early stages of the disease, it may be eradicated completely; and even in cases in which considerable headway has been gained the surgeon is able to give long periods of immunity from the return of the growth. Patients, however, are unfortunately familiar with the traditions of old-time wound treatment, and the dread of an operation is so great that they seldom act in the matter until it is too late to hope for a cure.

The operation for the removal of a malignant growth causes no real suffering when it is done by the surgeons of to-day, who employ anæsthetics for preventing pain during an operation and antiseptics for limiting inflammation afterward. The scientific antiseptic methods of wound treatment deal directly with species of microbes with which

naturalists are familiar. According to present beliefs, suppuration and "blood-poisoning"—pyæmia, septicæmia, erysipelas, and lock-jaw—are due to the growth in the wound of microbes which are parasites there; and within the last few years we have learned how to stop the growth of these microbes, and to prevent inflammation after operations with mathematical accuracy. In the application of these methods to the work of removing malignant growths, operators fearlessly expose all infected tissues for great distances, and remove every vestige of the disease in cases in which a few years ago they would not have dared to operate thoroughly for fear of the resulting inflammation.

Treatment by medicines is of no avail in curing malignant growths. The reason why medicines are useless in such cases is evident if we look at the subject through the germ theory, for it can be readily understood that any drug which is powerful enough to destroy cancer microbes would also destroy the blood-corpuscles. It is safe to say, that we shall never have a drug which will cure cancer, in spite of the statements contained in the patent-medicine advertisements. Local applications of caustics for the purpose of curing cancer are seldom made by reputable surgeons to-day, because a glance at the anatomy of a malignant growth is sufficient to show the folly of attempting to reach the deeply-infected lymphatic vessels with anything except the fingers aided by sharp eyes. Very small malignant growths can be cured by means of the local application of caustics, and large growths can sometimes be removed temporarily; and as this is easily done, charlatans have found a large field for work by appealing to the patient's dread of the knife, and promising to cure by milder means. While the patient is trying other methods than the one which surgeons of responsibility employ, the disease is usually getting such a foothold that opportunities for help are lost.

Many lives would be saved daily if cancer patients could be so educated that the delusions which lead them to tamper with so-called blood-purifying medicines and with irregular methods of surgical treatment would give place to fairly good reason. There are no secret methods of cure, notwithstanding advertisements to the contrary; and there are no ways or means for the cure of cancer that are not known to the responsible surgeons of all civilized countries.

Probably little can be done, however, in the way of directing the majority of patients properly, because the emotions of a victim of the disease are apt to be exalted, and the intellectual faculties are in consequence deprived of the exercise which they would have in conducting the ordinary affairs of life.

Legislation which prohibits illicit medical practice and the sale of useless medicines is becoming more and more strict in the European countries and in the large American cities, and it is through proper legislation alone that we can expect to see any marked decrease in the number of deaths which yearly occur from cancer.

THE INTERSTATE "LONG AND SHORT HAUL."

By HENRY WOOD.

THE passage of the Interstate Commerce bill marked a new era in national economic legislation. The immense magnitude of the interests involved, makes such a radical enlargement of legislative jurisdiction a very important event to the business interests of the country. In view of the bad effects of the long-and-short-haul clause which already have become apparent, it is assumed by many friends of the measure that there is a persistent effort being made on the part of the railway corporations to render the law odious, by the application of its provisions in an extreme and offensive manner. It is true that in many cases long-haul rates have been raised so as to correspond with the old short-haul tariff, instead of the shorter rates being reduced, and in the place of any such general and perfectly proportioned revision of tariffs as would be likely to exhibit the practical operation of the new law in its most favorable light. Such an effort on the part of railway managers could hardly be expected. It can not be denied that corporations are selfish, nor that their operations are conducted with a view to the largest possible ultimate profit. In this respect they are not unlike individuals who engage in business enterprises. In either case the motive is not philanthropy, but profit. While the object of the State in granting charters and creating corporations is the public good and convenience, the purpose of the individual corporators is gain. In any study of the relations existing between the public and the railways, these cardinal principles must not be overlooked.

Before examining specifically the long-and-short-haul clause, let us briefly consider the law as a whole, or rather the principles of general restrictive railway legislation. The recent rapid advance and expansion of legislative jurisdiction into new fields, and especially in the regulation of railway tariffs, where heretofore natural and elastic principles have been supreme, is a new departure of very doubtful utility.

An attempt to regulate *prices*, or *rates*, of any kind by artificial legislation, rather than by natural law, or supply and demand, is open to serious objections. The question which now forces itself upon the owners of the $4,000,000,000 (more or less) worth of railway property in the United States is, Where and when will the limit of legislative usurpation be reached? Where will the path lead which is being so rapidly traversed, and upon which such progress has been made in the recent past? It is evident to any candid and thoughtful observer that, if present tendencies continue unchecked, not only tariffs and incomes will be involved, but that the entire principal invested

in these great interests will be jeopardized. The value of any investment depends entirely upon its earning capacity, or upon the benefit or increase that can be realized from it. If the present or prospective earning power of any property is impaired, then, in the same proportion, the principal invested in the enterprise will be diminished in value. Proceed but a step further, and wipe out the revenue-producing capacity, and the total value of the investment is destroyed. These points are so plain as to be almost self-evident, but yet there is danger of their being overlooked or ignored.

What will be the result if the prices for railway service and transportation are to be controlled by the uncertain and often unintelligent action of a bare majority of a popular body of legislators. If members of Congress were all intelligent and conscientious experts, and if railway legislation were free from the element of demagogism, the case would be quite different. We are, therefore, forced to the conclusion that the time may be not far distant when not only the tariffs, but the veritable *value* of railway property will depend upon the whim and caprice of a bare majority of the ever-changing politicians who compose our national Congress. The railway interest of the country may well shrink from a near view of the logical sequence to the socialistic demagogism now so prevalent both in Congress and outside of it. An increasing number of pseudo-political economists are advocating governmental ownership of railways, among whom are found a few prominent professors and clergymen, who are distinguished for their voluminous *theories*, but whose ideas are destitute of any practical element. Any plan of transferring the vast railway interests of the United States, with which our general prosperity is so bound up, from *business* to *political* control, seems unworthy of candid consideration. With assets of four billions added to spoils already too great, to be fought over every four years by politicians, together with the unlimited patronage connected therewith, the result would be certain and utter corruption and demoralization. Many sentimental and visionary persons idealize the *Government* into a great infallible, all-powerful personality, which makes no mistakes, and which can accomplish impossible things; but the *real* Government is very unlike this ideal.

But let us return to the question, What are the proper limits of railway legislation? Clearly within these limits may be mentioned all such advisory powers and offices as are exercised so successfully by the Massachusetts State Commission, including the protection of the public by all proper moral, mechanical, and police restrictions and regulations. To these may properly be added regulations against discrimination, and the doing away with the abuses of the "free-pass" system. On the other hand, the domain of prices and rates is distinctly and properly *outside* of legislative jurisdiction, and, for the general good, should be left subject to elastic natural laws. Price-

making in any department is beyond the province of even the most perfect and ideal legislation. But some one will suggest, that while this proposition may be true of prices of commodities in general, that railways, having a semi-public character, and receiving by their charters certain privileges from the State, are exceptional in this respect. It will also be claimed that, in the absence of rate-restricting legislation, the public will have no protection against the rapacity of great corporations, whose object is solely their own profit. The fact is overlooked that, in the absence of legislative enactment, there is a sovereign *natural* law, which is fundamental in its character and unceasing in its operation. Entire dependence on demand, or the amount of business, forms a natural barrier against abnormally high rates, in addition to both direct and indirect competition. In tariff-making it hedges in the most powerful corporation.

Even in the absence of competition, any tariff that is much above the normal (or above that point which is natural and fair) will inevitably cause a falling off in business, so that profits will surely diminish. Though not always realized by the management, it is directly for the interest of any road to stimulate, develop, and increase its business by making a normal tariff, and only by such a course can the maximum of profit be reached. The greatest financial success lies directly in the line of the old adage, "Large sales and small profits." To quite an extent rates make themselves, and the arbitrary power of the management in this respect is greatly overrated by the general public. A railroad is not merely an improved public highway, but it is a complicated transporting machine. To successfully manage such an institution, or even to make, approximately, a perfect tariff, requires peculiar ability and talent, which is so rare that it commands a very high price. The tariff which is the most profitable for any given road, is not the one which is the highest, but that one which is the most perfectly adjusted, so that each kind and class of freight shall pay just what it will bear. Some will object to such an expression at first sight; but let us state it again, with an always understood qualification. A perfect tariff would be one so adjusted that each kind of freight would pay what it will bear, *compatible with its steady increase and development.* The profit lies in the increase of business, and not in abnormally high rates. It may be admitted that many roads often mistake their best interests in this respect; but experience is a persistent teacher, and, in the absence of legislation, rates have been tending steadily downward, and would have so continued. The principle is well illustrated by the successive reductions in the rates of postage. Within a short time after each reduction, the business has so greatly increased that, as a direct result, the profits have become larger than before.

Let us now briefly examine the point which is the cause of so much misapprehension in regard to the long and short haul. The provision

that no more shall be charged for a shorter than for a longer haul, under substantially the same conditions, seems, at first sight, to be perfectly fair and just. But the business of transportation is peculiar, and unlike any other in which the absolute cost of the article can be estimated. The actual cost of transporting any given quantity of freight is not a fixed, but a variable quantity, depending on a great variety of circumstances and conditions.

If we examine the nature of the expenses of the average railway, we shall find that about one half of the total amount consists of what are known as "fixed charges," which are usually made up mainly of interest on the bonded indebtedness. Of the remaining expenses, which include the cost of operating, about one half may also be regarded as fixed in its character, so that, on an average, about three quarters of the entire expenses remain the same, whether much or little business is done. This explains why certain kinds of business which are *created* by remarkably cheap long hauls can be profitably taken at very low rates, for it is almost so much clear gain to the road. All the necessary help, track, appliances, and machinery must be maintained, *whether it is done or not.* Shorter-distance rates, though higher in proportion, are yet a little cheaper than they could be in case this special cheap, long-haul business is destroyed by legislative regulation. Many of these special kinds of business have already been paralyzed or temporarily destroyed by the operation of the "long-and-short-haul clause," and can only exist under former free conditions. If they are destroyed, the quota they have heretofore paid toward railway revenue must be made up by other classes of business, and shorter rates must, therefore, necessarily be higher than before. As an instance, the long-haul business between New Orleans and New York or Boston, now being done by water, will deprive certain roads of some revenue they have formerly received, and, as a result, they will have to make its place good by higher local rates. Such an effect will be inevitable in the long run. It will be seen that the free, elastic, and ever-present operation of natural law in this, as in other kinds of business, will produce better results for all concerned than is possible from any amount of uncertain, spasmodic legislation, which at best will be artificial in its character. Such enactments in the department of rate- or price-making will only tend to hamper and embarrass traffic, obstruct commerce, and aggravate the abuses which it is vainly hoped may thereby be cured. Supply, demand, and competition are like great ocean-currents, silent, but powerful, and any attempts to set up artificial barriers will always produce friction, confusion, and loss. In any contest between the natural and the artificial, the latter must yield, and, if resistance is made, harmful results will surely follow.

This has been illustrated by "Granger" legislation, usury laws, and, in a variety of other attempts to override natural law, by a harmful excess of legislative enactment. The question of the present time

is, Shall commerce be permitted to run smoothly in its own natural channels, or shall it be hampered and obstructed by the changeable temper of uncertain and unintelligent legislation? *

VEGETABLE AND ANIMAL ALBUMEN.

By W. BERNHARDT.

HOWEVER numerous and prolific our investigations into the composition and properties of organic bodies may have been, we yet are very imperfectly acquainted with those processes by which these manifold forms of matter originate from simple constituents of air and water, and are as yet unaware of the causes on which the changes are depending that they undergo during life. We are acquainted with the artificial preparation of many of them, and still our experience is not sufficient to explain their natural origin.

We may produce oxalic acid, a body contained in the juice of many plants and also in certain animal secretions, by heating sugar together with nitric acid, but this is not the natural process of its formation, nor does it explain it. We imitate Nature in preparing grape-sugar from starch, but our method is different from hers, although the sugar we make by treating starch with hot dilute acids is identical with the product of the natural act of fermentation (caused in germinating grain by diastase, a product of decomposition of albuminous matter). It was considered a success of the highest scientific consequence, when Wöhler found out a way of artificially preparing urea, a matter resulting from

* Since this paper was written there has been another practical and important demonstration of the disastrous results of the long-and-short-haul legislation. The Canadian Pacific Railway, being free from any legislative shackles, is rapidly absorbing the traffic which otherwise would naturally seek the Pacific roads of the United States. A large diversion of the through transportation business from China and Japan has already taken place as a direct result of this remarkable policy of aiding our foreign rivals at our own expense. The handicapped condition of the American roads has been still further intensified in consequence of a recent renewal by our National Administration of a former concession, contained in the treaty of Washington, with her Britannic Majesty, which allows the transportation in bond of American merchandise from one port or place in the United States to another by a route, a part of which is by land-carriage, through the Dominion of Canada. By this means very large amounts of merchandise are now shipped from San Francisco and other American Pacific ports by steamers to the western terminus of the Canadian Pacific Railway, and thence brought over that line and distributed by American connecting lines to various commercial centers in the United States. Instead of fostering and building up the commerce of our own country, the Congress first takes away the freedom of competition from our carriers, and then our National Administration, while our legislative branch is not in session, restores to our rivals those special privileges which the Congress had abrogated in connection with the fisheries controversy. If such a peculiar joint policy by the legislative and Executive departments of our Government is long continued, and our Pacific roads can survive its effects, it will prove that they are possessed of great vitality.

the decay of muscular fiber in living animals; but yet, about sixty years after this event, we do not understand the chemical changes leading to that result. In a thousand other questions concerning the chemistry of human, animal, and vegetable organisms, our researches for finding satisfying interpretations have been futile, and even the most important query concerning the origin of life is likely to remain unanswered for many years to come.

There is a certain class of organic nitrogenous compounds, the origin, chemical nature, and decompositions of which are particularly far from being cleared up, although they concern the most indispensable functions of our own life, and are essential to vital energy in animals. Misunderstood, as many of their properties are, the facts which we know about them suffice to justify the high interest in their study which is manifested by chemists and physicians, as well as by the educated public in general. They are comprised under the name of albuminous matter, and have a very complex constitution, containing carbon, oxygen, hydrogen, nitrogen, and a small amount of sulphur. One of the chief features of their chemical character is a remarkable liability to decompose into the most various products. The best-known representatives of the group are—

1. Albumen, chief constituent of the white of egg and of blood-serum, dissolvable in water of common temperature, the dissolved matter coagulating and becoming insoluble when heated to 70° C.

2. Casein, dissolved as cheese in milk, coagulating upon addition of acids or certain ferments and warming.

3. Fibrin, coagulating from blood upon its exposition to air.

Plants are the manufacturers of albuminoids, or proteids, as they are also called; transformation of carbonic acid, water, and nitrogen, which are permanent constituents of the atmosphere and soil, into those combinations which constitute the body of plants, and which are designed to effect their propagation, is the chief function of the roots of plants. Among these combinations albuminoids are the most important, both for the vital process of the plants and as food for animals. From this reason the question of their origin has induced numerous investigations, to which we owe the knowledge that certain other nitrogenous bodies, called amides, which in varying amounts seem to be present in the roots of all plants at the time of beginning growth, play a prominent part in the genesis of albuminoids. The amides best known are asparagin (originally found in the shoots of asparagus) and leucin. The conclusion to which these researches have led is that sugar is formed in the root partly from starch by the action of diastatic ferment, partly by direct assimilation out of carbonic acid and water. Combination of sugar with one of those amides results in the formation of vegetable albumen, from which the rest of the proteids are derived by slight variations of chemical composition. Vegetable albumen being of a very unstable nature, is partly again decomposed

into amides and sugar, and, while the latter is used in accomplishing the structure of the plant by changing into cellulose, the amide is again transformed into albuminoid, and by decomposition reduced to amides. Thus, by continually assimilating carbonic acid and water, combining with them to form albuminoids, and giving them off again as sugar, the amides act a prominent part in the development of plants. New supplies of amides, in the mean time, are continually formed, while the albuminous matter is partly transferred to remote organs, where, exposed to light and other agents, it undergoes various decompositions, by which the deposits of solid proteids, alkaloids, and many other bodies are produced. A certain quantity of proteids becomes stored up in the seeds, modified into gluten, or legumin, for the purpose of hereafter entertaining and supporting the life and growth of the offspring. Vegetable albumen, gluten, and legumin so closely resemble animal albumen, fibrin, and casein, that the same names have been given to them.

In thus tracing the origin of albuminoids in plants, we see them partly dissolved as vegetable albumen in the juice (upon the heating of which coagulated albumen gathers as foam on the surface), partly as "plasma" forming the contents of cells, and partly as solids in various organs, but chiefly in the seed, which by their presence acquires more or less valuable properties as food for animals, the nutritive value of grain and leguminous products being due merely to the high percentage of gluten and legumin contained in them.

Plants, indeed, are the sole source on which most animals depend for their food, for they are incapable of assimilating the constituents of air and water, as vegetables do. Only in the most simple forms of animals, such as moneres and amœbæ, the question is undecided whether such an assimilation takes place or not; but our knowledge of the limits between these low forms of vegetable and animal beings is very imperfect, and, in view of the numerous parasitic plants which draw their food from other organisms, we can not declare the source and process of nourishment to be a correct and pervading mark of difference between the two classes. If, however, some one should raise the objection that animals of prey do not depend upon plants for food, he might easily be corrected by showing that, in feeding on vegetable-eating creatures, they "indirectly" live on the plants themselves.

The changes which vegetable proteids undergo by being taken up into the animal organism are insignificant at first; having been transformed into soluble bodies (peptones) by pepsin, the digestive agent of the stomach, we see them appearing again in the circulation of blood as albumen, globulin, fibrinogen, combinations of very similar character to the proteids of plants. There is, indeed, no practical difference existing between albumens and legumins. The proteid of beans, peas, lentils, etc., is identical with casein, the proteid of cheese, as to composition and properties.

Blood, upon leaving the vein, is separated into a liquid and a solid part by fibrinogen, one of the proteids dissolved in it, undergoing a change, by which it becomes insoluble fibrin; muscular plasma, the semi-solid constituent of muscular fiber, by solidifying after death, and changing into fibrin, affords the well-known phenomenon of *rigor mortis*. It is a process closely resembling these, by which one of the soluble proteids of gluten, by accession of air and water, is transformed into insoluble gluten fibrin.

The conformity existing between the nitrogenous compounds of vegetables and animals is not limited to the proteids mentioned, but extends to various products of their decomposition. Diastase, the fermentative agent originating from proteids in the seeds of many plants during germination, is also present in the saliva of animals, where it exerts upon amylaceous foods the same action of forming sugar from starch. Agents very similar to pepsin, the digesting ferment of the stomach, are to be found dissolved in the juices of various plants; upon contact with muscular fiber, or coagulated albumen, or cheese, they will dissolve these bodies, and transform them into peptones as well as pepsin does. Thus papayotin, a substance extracted from the juice of *Carica papayu*—a kind of fig-tree—is therapeutically applied for dissolving morbid membranes and tumors; not less are the well-known insect-devouring properties of the leaves of *Nepenthes*, *Drosera*, and *Utricularia*, due to the presence of such ferments in their viscid secretions. Leucin and tyrosin, amides occurring in the roots of plants, which are both products of decomposition and regenerators of albuminoids, are also found in animal organs. The inflammation of skin, caused by touching a nettle, has been ascertained to be due to a kind of decomposed, or changed, proteid; and the virulent properties of the secretions contained in the venom glands of serpents having become known to depend on proteids, the conclusion appears well founded that the virus of insects and other animals also owes its pernicious effect to metamorphosed albuminoids, too, rather than to formic acid, as had been hitherto believed.

Many facts have been produced to show that, as the theory of evolution supposes, there is a degree of consanguinity existing between plants and animals: sexual differentiation, for instance, is common to the higher forms of both of them. Sexes in both cases are sometimes united in the same individual, sometimes separated. The lowest species of both of them, consisting of single cells, propagate by simple division. Scarcely a characteristic has been discovered in these living cells of plasma, which might justify the making of a distinction between plants and animals. The voluntary movement ascribed to the latter class is not plainly discernible in many cases, while many low plants, such as *diatomaceæ* and certain bacteria are eminently and continually engaged in lively motion. No striking difference is to be observed in the sources of food and in the way in which it is

taken. If to these facts the results of chemical investigations be added, showing that many constituents of the greatest vital importance in both are identical, and that a close relationship of others (vegetable and animal fats) is beyond doubt, we may justly claim that chemistry has contributed and will further contribute considerable support to the doctrine of evolution, if identity of matter may be regarded as evidence of consanguinity, or as a proof of common descent.

Considered from another point of view the mutual relations existing between both classes of beings are of a decidedly hostile character. The fierce "struggle for life," which causes animals to kill and to devour their fellow-creatures, is in a not less merciless degree extended to plants; and victory is not, as we might fancy, always on the side of the more perfect creature. Even man, the most accomplished being, and at the same time the most relentless despot on the earth, though without much personal trouble he may fell the strongest trees and eradicate whole forests, is yet liable to succumb to the attacks of a few micro-organisms invisible to the human eye. A theory, at first pointed out by Pasteur, accepted by Virchow, and of late experimentally confirmed by Metschnikoff, teaches, that certain low plants, fungi, called microbia, or bacteria, said to be the primary causes of infectious diseases, when entering the circulation of blood or one of the important organs of the body, become at once engaged in a struggle with the living cells of the organism, both adversaries endeavoring to kill and to devour each other; the result of this fight, if the microbia are victorious, is said to be the death of the animal.

In a lively and perspicuous representation Metschnikoff has described one of these destructive combats. *Daphnia*, a sweet water crustacean, served to him as the first object on which he could observe the attack by monospora, a fungus of the lowest order. As soon as the latter began to invade the body of Daphnia it became surrounded and entangled by numerous cells (*leucocytes*) engaged in lively motion, which gradually from all sides attached themselves to the fungus and destroyed it by some kind of intercellular digestion, or absorption. It is evident, that a single cell could not afford to give out so much dissolving matter as was required for this purpose; it would even probably have succumbed to the enterprising enemy; but by the assistance of its confederates it succeeded in overwhelming the intruder. In eighty cases out of a hundred, according to Metschnikoff, the cells would be victorious, but in twenty cases the fungus would gain the battle, with the consequent death of the Daphnia.

Concerning this view and interpretation of the origin and progress of infectious diseases, we are inclined to believe that, since bacteria have not been found in all of them, and since, where they are present, also certain products of chemical decomposition of proteids, ptomaines, occur with them—the dangerous phenomena and the lethal end of such diseases should rather be ascribed to the well-known virulent proper-

ties of these products, as is done by many eminent physicians. Bacteria may frequently be the bearers and transporters of disease, as flies are accused of communicating the virus of splenic fever to healthy individuals.

The germ theory, which declares micro-organisms to be the cause and originators of infectious diseases, although it seems to be at present recognized by many physicians, perhaps by the majority of them, is as yet far from being thoroughly established. The action and influence of bacteria have evidently often been exaggerated. Pneumonia was ascribed to them, until it was found that in some pneumonitic cases bacteria are present, whereas in many others none could be found. In hydrophobia a particular micro-organism, although most eagerly sought for, has not yet been discovered. The possibility, however, of transferring this disease from one to another animal by inoculation indicates that the virus may consist of some kind of decomposed proteid, acting as a chemical ferment upon certain constituents of blood, or nervous substance. We may, by the existence of such ferments as diastase, pepsin, or as the virus of serpents and insects in healthy individuals, conclude that other not organized ferments exist in and are the cause of morbid conditions; and although most of the fermentative processes, on which epidemical diseases depend, seem to be induced and to increase by the agency and propagation of bacteria, there is no reason for making them accountable for other troubles to the extent that has hitherto been done. There are organized and unorganized ferments existing, both of which are known to produce decomposition of organic matter. We hope and expect that the future will decide what effects in animal and human diseases belong to each of them.

AN OUTCAST RACE IN THE PYRENEES.

UNDER the name of Cagots there live in the Pyrenees and the old Aquitanian regions on both sides of them—in the Spanish Upper and the French Lower Navarre, in Béarn, Gascony, Guienne, and Lower Poitou—a peculiar race who have been much talked about and have attracted the attention of the peoples about them from very ancient times. Formerly the Cagots (whose name linguists derive from *canis Gothicus*, Gothic dog) were confounded with Cretins. The association was a mistaken one for the Cagots, with their large, muscular forms, shapely skull, prominent nose, strongly-marked features, blue eyes, and smooth, blonde hair, are decidedly different from that weak-minded, deformed, and goitrous class; and their physical appearance, in fact, goes to sustain the etymology of their name that we have mentioned, and to indicate a possible derivation from the Aryan Goths. The type of which we speak also corresponds fully with the race-rela-

tives of the Cagots living outside of the Pyrenees, who are variously called, according to the place, Cahets, Caqueux, Caquins, Cacoas, Collibrets, etc., and are spread to Lower Poitou, in Brittany and Marne, and far down into Spain.

The race of the Cagots was for hundreds of years superstitiously avoided by the other inhabitants of the country, despised, persecuted, repelled, treated as if abandoned and outcast, and restricted in all legal and social rights. Dark superstition and the prejudice of earlier times attributed to them a constant leprosy; they were supposed to have a peculiar repulsive exhalation, to be destitute of earlaps, to be color-blind, to see in the night like cats and owls, and were accused of pretended, likewise disgraceful offenses. They were treated as feeble beings, afflicted with contagious disease and moral impurities, who should not be touched, and with whom as little business intercourse should be had as possible. Down to the seventeenth century they were thus treated. If they lived in the towns, they were confined to a particular quarter in which the other citizens rarely came; if they came out of their quarter, they were obliged to wear a piece of red cloth on some conspicuous part of their dress, so that others might recognize them and keep away from them. On the plains they dwelt for the most part in miserable huts, which were separated from the town by a wood or by running water. In the church they were separated from the rest of the congregation by a wooden partition, and had to go in and out by a separate door. Holy water, the communion, and the other blessings of religion were forbidden them, and they could take part in the processions only under particular conditions; and the corpses of their dead were buried, without bells and music, in a separate burial-ground, or in a separate corner of the common cemetery.

The same kind of contempt and ill-treatment was measured out to the relatives of this race in other Pyrenean provinces, where they were formerly numerous, but have now nearly died out in consequence of persecutions. The Agotes, as they were there called, were formerly very numerous in the Basque provinces, and they can still occasionally be found sprinkled among the people. They were there equally despised and regarded as an unclean race, excluded from association with the rest of the people, compelled to seek abodes in caves, secluded hamlets, and miserable huts; they could fill no office; could not sit at table with other persons, or drink out of the same cup for fear that they would communicate some poison or impurity to the dish; and were not allowed to go into the church to receive their portion of the mass, but had to wait at the door till the priest brought it out to them. Marriage with them was as disgraceful as if it were with Moors, gypsies, or other non-Christians; and they were supposed to communicate disease and horrible ills to whoever touched them. The Cahets in Guienne were the objects of similar reproach and adverse regulations.

The reason of the superstitious prejudice and hatred against this peo-

ple and their origin has not been discovered, although the subject has been an object of investigation and much discussion during the last four hundred years. The conjecture already referred to, which has long prevailed in France, that the Cagots and other despised castes in the Basque lands were descendants of the Visigoths, who were conquered by Clovis, and fled to the mountains, has been shown to be baseless and untenable. Many of the most esteemed and distinguished families of Gascony, Aquitaine, and Béarn were descended from the Visigoths; and those brave heroes were not afflicted with any of the personal defects, or anything like them, which were attributed to the Cagots.

Another conjecture, which was partly held to by the Cagots themselves, made them descendants of the Albigenses, whom Pope Innocent III outlawed and banished in the beginning of the thirteenth century. It is an historical fact that these poor persecuted heretics or opponents of the papacy were then regarded as the scum of mankind; but then they received in these districts of the present France more sympathy and adhesion than the popes themselves. Moreover, the Cagots were in existence as a despised race more than two hundred years before the crusade against the Albigenses. Pierre de Marca thought that the Cagots were descendants of those Moors from Spain who remained in Gascony and Aquitaine after their leader had been vanquished by Charles Martel on the slopes of the Pyrenees. But this view is contradicted by the decided northern type which is still recognizable in the bodily appearance of the Cagots, and by the historical fact that those Moors were eventually converted to Christianity, and became blended with the other French nationalities.

Caxar Amant ascribed a Jewish origin to the Cagots, and endeavored to sustain his opinion by a garbled quotation of a Biblical verse. Another writer made them descendants of the Jews who came to Southern Europe after the destruction of Jerusalem by Titus. Abbé Venuti supposed that they were descendants of Crusaders who returned from the Holy Land after the first Crusade, afflicted with disease. Count Gebalin saw in them the descendants of the aborigines of the Pyrenean lands, who were reduced to a condition of outlawry like that of the lowest castes and tribes in modern India. Another view, by which they were regarded as the descendants of those Spaniards who were in the conspiracy against Charlemagne and participated in the battle of Roncesvalles, has been disproved by a comparison of dates and places.

The later explanations of the origin of the Cagots are more plausible, though not quite historically convincing. A French investigator, M. Francisque Michel, has written a valuable book on the "History of the Accursed Races of France and Spain," in which he has sought with great consistency, as M. Louis Lande has also done in the "Revue des Deux Mondes," to prove that leprosy was the cause of the terrible and ignoble treatment which the Cagots have had to endure.

There is not in France or Spain any particular sect or district which has made itself conspicuous by the indefinite fear of these outcasts. But if we consider the popular belief, which persisted to a very recent period, that they had been or still were afflicted with leprosy, all will be made clear. Etymological research has shown that the name Cagot is associated with this disease in several of the French dialects. Evidently, if the fact or the opinion that the Cagots had been afflicted with leprosy was the provocative to the treatment which they had to endure in the dark ages, most of the prejudices against them would correspond with those which were formerly entertained against lepers. A later French writer, M. de Rochas, who has made a thorough study of the history and condition of the Cagots, in order to explore the subject to the bottom, made several journeys in the northern and southern outlying provinces of the Pyrenees during the last Carlist war, and visited some of the Cagots still scattered here and there among the population. He found everywhere that the descendants of the Cagots were quite like the rest of the population in bodily and mental characteristics, that they in no way suggested a strange origin, nor were they distinguished by any unusual or abnormal mark. He found, also, that while marriages of the Cagots with the rest of the population were rare, the two classes associated together on the same footing, their grown people and children attended the same churches, and that they both exhibited about the same degree of mental capacity. Every trace of leprosy, goiter, and cretinism has disappeared from among the Cagots of to-day. Some of them, it is true, are afflicted with scrofula, which, however, is not of hereditary or pestilential origin, but is traceable to poverty, insufficient food, poor, filthy houses, and physical neglect. In a Spanish commune, among whose inhabitants were many descendants of the once outcast race, M. de Rochas found those persons vigorous, healthy, sagacious, and apt; they were tilling small plots of ground, raising swine and hens, and pursuing about the same occupations as their neighbors. They were still patiently subject to a few of the old hostile usages of exclusion—for instance, to the prohibition of marriage outside of their own circle—but only because it was an old custom, for which they or their neighbors could not give a sufficient account. The members of the Cagot village were not physically or morally distinguishable from the rest of their countrymen; and it was plainly to be seen that the old prejudices against the Cagots had died out.

The French government and laws before the Revolution did very little for the protection of the Cagots. Better conditions have grown up since then. As soon as science began to busy itself with the investigation of the phenomena of Cagotism and to expose the baselessness of the prejudices against those people, the prejudices began to weaken; and they seem now to have quite disappeared.—*Translated for the Popular Science Monthly from Das Ausland.*

SKETCH OF SIR JOSEPH WHITWORTH.

THE value of Sir Joseph Whitworth's work, and the extent to which it has entered into common life, are exemplified whenever a screw-tap is fitted to a bolt. A biographical sketch of him, published on the occasion of his death, designated his name as the greatest of our time in mechanical engineering, and characterized him as a person of remarkable individuality and one whose efforts have left a permanent impress upon the workshops of the whole civilized world.

JOSEPH WHITWORTH was born at Stockport, England, on the 21st of December, 1803, and died at Monte Carlo, January 22, 1887. He was taught by his father, who was a schoolmaster, and at a school at Idle, near Leeds, till he was fourteen years old, when he was placed with his uncle, a cotton-spinner in Derbyshire. The operations of manufacturing were not to his taste, but he soon made himself at home with the machinery of the establishment, and in time became its practical managing engineer. After six years of this work he desired to find a wider field for the development of his mechanical abilities, and, although the value of his services was appreciated by his uncle, he ran away to Manchester, where he spent four years in acquiring a practical knowledge of the manufacture of cotton-machinery. Applications of steam-power were still new and crude, and tools adapted to use in connection with the new force were imperfect or wanting. In order to qualify himself to supply the need thus indicated, he went to London and sought employment in the best shops—Maudsley's, Holtzapfel's, and Clement's. Maudsley, recognizing his skill, took him into his own private room, and placed him next to his best workman. He worked in off-hours at his own devices, and in this way completed the true plane, an instrument which conferred the power of making surfaces for all kinds of sliding tools, by which the resistance arising from friction was reduced to its smallest figure, and of which he published a description in 1840. He showed his device and its operation to his fellow-workman, Hampson, who had been accustomed to ridicule his experiments, but now testified his appreciation of the work by saying, "You've done it." At Clement's he worked upon Babbage's calculating machine, which he always maintained would have operated perfectly if it had been gone on with; and here also he learned to make a true screw.

In 1833 Mr. Whitworth engaged in manufacturing on his own account at Manchester, establishing himself in one room and putting out the sign, "Joseph Whitworth, tool-maker." It was in the infancy of extensive manufacturing, and there were no fixed standards of adjustment, no guarantees for accuracy of work, or attempt at symmetry or uniformity in any respect, but each maker was a rule to himself.

Whitworth foresaw that if industrial enterprise would prosper it must be systematized, and workmen must install harmony in their designs, and must aim at minute exactness in their forms and measurements. His attention was particularly directed to the inconveniences which were produced by the variations in the pitch and thread of the screws used in the construction of machinery—variations so considerable, if we may quote the words of an English sketch of his work, "that every maker had screws of his own special sizes, and that the failure of a single one might cripple a machine in a distant country until the original maker could be communicated with and could send out another of the same proportions. Mr. Whitworth not only saw the immense advantages which would arise from rendering the pitch and thread of screws uniform, but also the difficulty which might be experienced in inducing any maker to adopt the proportions used by any other. With rare sagacity, he obtained specimens of all the screws used by leading manufacturers, and then designed one which was the average of them all, and a copy of none. By this expedient he evaded opposition, and worked a revolution in the construction of machinery. The new screw was universally adopted; and, in the present day, every screw of the same diameter has a thread of the same pitch and of the same number of turns to the inch, and all screws of the same size, from whatever maker obtained, are interchangeable."

Mr. Whitworth next took up appliances for accurate measurements, and constructed an instrument capable of measuring the millionth part of an inch, and which, worked by touch, "was so delicate as instantly to communicate the expansion of a steel bar three feet in length when this was warmed by momentary contact with a finger-nail." With these and his other inventions, "Whitworth's standard gauges, his taps and dies, his uniform system of screw-threads, his great refinements in the manufacture of lathes, planing-machines, drills, etc., all became available at the moment when they had become indispensable, . . . if the imperative demands for mechanical appliances in every direction were to be worthily met."

In 1853 Mr. Whitworth was appointed a commissioner to the great exhibition in New York, and in that capacity wrote a report on American manufacturing industries which attracted much attention at the time, and still has interest. In the next year he was requested by the British Government to design and produce machinery for the manufacture of rifles for the army. He found it with the rifles as it was with nearly all mechanical appliances before he touched them to improve them—no two of them were alike. He imposed as a condition of his accepting the commission that he should be permitted to determine what form and dimensions of guns and bullets would produce the best results. Besides consenting to this condition, the Government erected a shooting-gallery five hundred yards long on Mr. Whitworth's grounds at Rusholme, where he was able to devote himself to most careful and thorough ex-

periments. Here he determined the effects of every pitch and kind of rifling, and of every length of projectile, from the sphere to a missile having a length of twenty times its diameter; and the principles which he determined upon, of a projectile elongated to from three to five times its diameter, with a rapid rotation and a quick uniform rifling pitch of polygonal form, have been extensively adopted.

The same principles were found to be equally applicable to large guns, and the continued labors of the discoverer of them resulted in the production of the Whitworth cannon, which are declared to be the best the world has yet witnessed, "the most enduring, the most accurate, the most powerful in penetration, and the longest in range." But with all these advantages "the principles established by Whitworth were not adopted into the service, for reasons which it would probably be more curious than edifying to investigate."

Mr. Whitworth was embarrassed in the prosecution of his experiments by the difficulty of getting metal of the right kind. Mild steel, which gave the nearest approach to the desired qualities, was not wholly satisfactory, because the same properties which gave it toughness and ductility, gave also a tendency in the course of cooling, to imprison the escaping gases and cause unsoundness. To obviate this defect he applied the process of compression with hydraulic power, whereby the particles of the fluid metal were driven into closer contact and the gases were squeezed out. This process, by which the greatest strength was combined with the least weight and bulk, proved to be generally applicable, and is now largely employed for those structures in which it is desired that those qualities shall dwell together.

Early in 1869 Mr. Whitworth founded the Whitworth scholarships, assigning for the purpose £3,000 a year in perpetuity, or the interest on a capital sum of £100,000. The fund was vested in the President of the Privy Council, or other minister of public instruction for the time being, and was intended, as its institutor explained in a letter to Mr. Disraeli, to promote the engineering and mechanical industry of the country by a system of scholarship prizes to be made accessible on fairly equal terms of competition to students combining some practice with their theory, and to intelligent artisans uniting some theoretical knowledge with perfection of workmanship. The scholarships were valued at £100 a year, and were tenable for three years, to be obtained on competitions which were open to all Her Majesty's subjects at home, in India, and in the colonies, who had not completed their twenty-sixth (afterward changed to twenty-third) year. By regulations afterward prescribed to insure the holders of the scholarships devoting themselves to the studies and practice necessary for mechanical engineering during the tenure of the scholarships, it was required that every candidate should produce a certificate that he had worked in a mechanical engineer's shop or in the drawing-office of a mechanical engi-

neer's shop, for two years consecutively; that he should be examined in the appointed sciences; in smith's work, turning, filing, and fitting, pattern-making, and molding, "as already established"; and that after 1875 each holder of a scholarship should be required to produce satisfactory evidence, by examination, at the termination of every year, that he had made proper advances in the sciences and practice of mechanical engineering. Additional prizes were offered for the best evidences of scholarship at the annual and final examination, so that it became possible for the best of the scholars at the end of his tenure of the scholarship to have obtained £800, and the others in proportion. The benefaction was added to, in 1875, by the foundation of a number of "Whitworth exhibitions."

Mr. Whitworth was made a Fellow of the Royal Society in 1857; he received degrees from Trinity College, Dublin, and the University of Oxford; obtained, in 1867, for his collection of engineer's tools and rifled ordnance and projectiles, at the Paris Exhibition, one of the five "Grando Prix" allotted to England; had conferred upon him by Napoleon III, in 1868, the decoration of the Legion of Honor; was awarded the Albert Gold Medal of the Society of Arts "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a degree of perfection hitherto unapproached"; and, in 1869, he was created a baronet, and became Sir Joseph Whitworth. He suffered for several years from the severities of the English winter, and went every year to the Riviera. Two years before his death he had built a winter-garden at Stanley Dale, to which he was confined for several months; but on the approach of cold weather in the fall of 1886, he determined, although he was so weak that his friends saw him depart with much misgiving, to try the Mediterranean coast again. "He leaves behind him," says the "London Times," "a reputation unapproached in his department, and he was scarcely less remarkable for the sagacity which he brought to bear upon great public questions, than for the severity with which he saw his conclusions put aside by men in official positions, whose minds were not mechanical, and toward whom his feelings scarcely rose to the level of contempt. The characteristics of his intellect were peculiar in that he was distinctly an experimentalist as opposed to a reasoner. When a problem in mechanics was presented to him, it was his habit to say, 'Let us try,' and he possessed the rare gift of being able to devise conclusive experiments." His principal published book was a collection of "Essays on Mechanical Subjects," including true planes, screw-threads, and standard measures, which was published in 1882. He left a large part of his estate to be applied to purposes of instruction in mechanical engineering.

CORRESPONDENCE.

A DIFFICULTY REGARDING EVOLUTION.

Editor Popular Science Monthly:

THE article of Professor Joseph Le Conte in the "Popular Science Monthly" for October, upon the subject "What is Evolution?"—the clearest, fullest, and fairest presentation of the subject we have ever met with—suggests afresh an insuperable difficulty to our entire and hearty acceptance of the doctrine of evolution. With a view to obtaining light upon this dark part of the subject, we beg leave to state it in as brief space as possible. And in doing so, we indulge no conceit that we are the first either to experience the difficulty or to call public attention to it. We simply affirm that we have never met with any explanation whatever of it in any of our not very extensive scientific reading.

After putting forth his admirably conceived and worded definition of evolution, Professor Le Conte remarks that "Embryonic development is the type of evolution." It is just here, in this typical expression of evolution, that our initial difficulty arises. It is this: Is there in all the realm of organic life a known embryo existing (that is living) apart from its parent organism? Must we not have the latter before we can have the former? True, the chicken is evolved from the egg; but who can determine which, the chicken or the egg, was first in order of time? We no more have any knowledge of an egg ever having existed independent of the agency of a mature male and a mature female organism, than we have of the existence of a chicken that was never hatched from an egg.

And if we go back of the egg or the embryo a step, and consider that primal substance of organic life, protoplasm, is it not equally true of this, that it is nowhere found, except as a part of or a belonging to some organic form? Is it not in fact a secretion, a vital fluid product of a living organism? And has protoplasm ever been separated from its normal organic *locus*, without thereby involving an immediate destruction of its potentiality? Who, therefore, may affirm that protoplasm is the antecedent, the primordial phase of organic life, rather than the reverse of the statement?

The procedure from protoplasmic spherule to mature organism is not a final or complete one; for, no sooner has the organism attained its full growth, than in conformity to the law of propagation—as much a law of organic being as growth itself—it at once proceeds to reproduce itself. And so the processes of life, when viewed in their entirety, would seem to constitute a circle, every point of which is equally instinct with progressive vitality, and whose most complex phase (the organism) is immediately joined to the simplest phase (protoplasm). Who, therefore, may put his finger on the embryonic cell and say, "Here was Nature's starting point," with any greater assurance of the absolute truth of his position than another may claim who believes that in the mature organism exists the real source, the fountain-head of life?

We are free to confess that, of the two hypotheses just noticed, the one which places the possible initiative of organic life in possession of a mature organism, seems to us by far the more patent, the one most nearly in accord with the hourly teachings of surrounding nature. Like Ajax, we petition for light.

M. K. ROYSE.

CINCINNATI, OHIO, *October*, 1887.

WHY HAVE WAGES RISEN?

Editor Popular Science Monthly:

IT would be difficult to praise too highly the articles of Hon. David A. Wells, on "Economic Disturbances since 1873," in late numbers of the "Popular Science Monthly." To read them has been a delightful experience, but there is one question which I am surprised to find that he has not brought forward, and that is, why have wages for manual labor risen to such a height when all other prices have been falling to lower and still lower marks for fourteen years? Almost every argument that Dr. Wells has adduced to account for depreciation elsewhere, would assist in proving that labor should also be low. Overproduction, while cheapening the product, should cheapen the work that produces it, and if it be said that machinery by doing so much and by multiplying the efficiency of each pair of hands causes the money paid for labor in our large industrial establishments to be relatively but a small part of the cost of production, thus enabling capital to pay and labor to exact higher wages for work, the comparative poverty of cotton and woolen-mill operatives and of women who run sewing-machines, does not sustain this view of the case. There are few circumstances connected with the economical disturbances of to-day so difficult to account for or whose consequences reach so far and are so generally felt as the increase in laborers' and

mechanics' pay. With the day's work rated at one dollar, farming here at the East would be a remunerative occupation, but with wages at twelve and fourteen shillings agriculture in New England is dead. A gentleman, whose little fortune of $10,000 brought him at 7 per cent an income of $700 just before the war, thought himself on a somewhat higher social plane than his neighbor the carpenter who, working 240 days out of the 365 at $1.50 per day obtained $360 for his year's labor; but nowadays receiving $720 for the same labor for the same period, the mechanic looks down condescendingly upon the possessor of ten myriads of dimes, whose annual income at 4 per cent is reduced to $320 less than his own; and, to beautify this picture by adding the proper sidelights and shadings, the property-holder is heavily taxed to educate the carpenter's children while he, the carpenter aforesaid, howls for higher wages and less hours of work and weeps copiously over the oppressive rapacity of capital. One might proceed through all social grades and all human occupations, and everywhere find high wages effecting disturbances in some cases beneficial, in others disastrous, but always attended by low prices for everything else and by circumstances which should depreciate the price of labor also, and yet it would seem that the workman is most in demand and paid the best where his products are most overproduced. Why should this be so? Will the Hon. David A. Wells attempt an answer?

W. B. Weed.

Darien, Connecticut, *December*, 1887.

OYSTER-FATTENING.

Editor Popular Science Monthly:

Sir: I have only to-day had the good fortune to see Professor Atwater's most interesting paper on the chemistry of oyster-fattening. I am induced to say that thirty to thirty-five years ago it was common for well-to-do families in the North of Ireland—County Derry—to buy oysters by "the long hundred," that is one hundred and twenty, and to lay them down in tubs or pans in fresh water, with a very little salt added. When they had been so laid down a few hours, some oatmeal was thrown into the water, in pinches, and they were thus "fed" for two or three days when they were found heavier, plumper, and more delicate in flavor. If I recollect rightly, they were also made whiter by this process. Was the effect wholly imaginary, or did the oysters really assimilate the oatmeal, which was always of the finest, that is, the flouriest, sort?

Yours truly,

Charles Williams, F. R. G. S.

New York, *November* 22, 1887.

EDITOR'S TABLE.

THE "ACT OF GOD" AND "HUMAN RESPONSIBILITY."

NOW and again, amid the rush of modern progress, we catch a note or sign of reaction. Such a note we most distinctly have in the article published a couple of months ago in "Science" over the signature of Mr. Appleton Morgan. Mr. Morgan is a lawyer of distinction, whose talents have been largely employed by railway companies, and who has thus naturally contracted a sympathy, very allowable in its way, for those corporations. But to say that Mr. Morgan is a lawyer in active practice is almost tantamount to saying that his line of thought and argument on any given practical subject will be forensic rather than scientific—that is to say, that it will be skillfully adapted to lead up to a prearranged conclusion rather than to bring out all the truth that is obtainable in connection with the matter in hand. Mr. Morgan writes a clever article to prove that some railway accidents proceed from causes so far beyond human control that we might properly apply to them the old expression, "the act of God." The suggestion is that in such cases the railway companies should hardly be held accountable. What we are not given, however, is any clear principle of distinction by which accidents for which railway companies might, in Mr. Morgan's opinion, properly be held accountable may be separated from those where all responsibility fails, and "the act of God" must be invoked as the only hypothesis suited to the case. Yet, without some such clear principle of distinction, the whole

of Mr. Morgan's labored argument rests *in nubibus:* it is very fine, from the special pleader's point of view, but we get no practical results from it.

We have spoken of this article as a note of reaction, and so, most emphatically, it is. The progress made in modern times has consisted very largely in the banishing from our thoughts and calculations of all faith in occult agencies, and in the establishment of the habit of tracing everything that happens to some intelligible, if not always controllable, cause. So long as sprites, goblins, and imps were seriously believed to interfere in human affairs, so long it was impossible to hold men to a strict responsibility for their actions; and when things went amiss, no truly scientific inquiry into the causes of the mischance was ever instituted. To say that it was "the act of God" was the easiest way out of the difficulty, and the most satisfactory, certainly, to those upon whom the blame might properly have fallen. But science has been teaching mankind to search out real causes, and to dismiss purely imaginary ones; and just as the disposition to do this has developed, and just as men have been taught that they can not put all their sins of omission and of commission on the shoulders of invisible agencies, have accidents and irregularities of all kinds diminished in number. Mr. Morgan admits this. He says that, up to a very recent date, courts of justice habitually saved time and routine labor by assuming accidents, the causes of which could easily have been arrived at, to be "acts of God." He tells us that, in a very recent case, while the principle involved in the expression, "the act of God," was recognized by the court, it was held that a shipwreck, in order "to be a veritable act of God, must have occurred in extremely bad weather." We should rather have supposed that the "act of God," if recognizable at all, would have been recognized in the foundering of a ship in calm weather. It was the thunder-clap that he heard from a clear sky that so strongly affected, for a brief period, the not ordinarily very devout mind of the poet Horace; and Mr. Morgan seems so far to agree with that "sparing worshiper of the gods" as to hold that in the case of railway accidents the "act of God" is most visible, not when the conditions are unfavorable, but when, on the contrary, they are highly favorable, save in the one point in which a quasi-supernatural interference is exemplified.

Admit the principle in question at all, however, and we are back in the dark ages; we cease, indeed, to be fit to run railways. It is one thing to bow with resignation to a calamity after it has happened, and quite another to anticipate that calamities will result from the "act of God," and so far make provision for them beforehand. How is the "act of God" to be checked? How are we to prescribe the frequency with which such acts are to be performed? If, in the presence of such acts, we really find ourselves outside of the bounds of human responsibility, why try, by any human means, to guard against their recurrence? We venture to say, however, that no railway accident ever occurred that was not followed by more or less strict inquisition into its cause, and that did not give rise to measures intended to prevent the same thing happening again in the same way. Some of the facts mentioned by Mr. Morgan himself tend to show how little need there is to have recourse to divine intervention to explain the occurrence of any class of railway accidents. He tells us that until within a very few months the strides made by science "seemed to have happily abolished—in the United States—the great railroad disasters of the past." Fifteen or twenty years ago there were a number of frightful accidents, but since that time accidents involving great loss of life have been very infrequent.

Now we plunge once more into an era of disasters. But what does this suggest, if not that prolonged immunity from accident due, as Mr. Morgan says, to the strides of science and to skillful organization, had led to a less vivid realization of the dangers attendant on railway traffic, and a consequent relaxation of vigilance. This is just what would naturally happen, so why invoke the "act of God" to explain what natural principles are quite sufficient to account for? All things tend more or less to move in cycles; all action, we might almost say, tends more or less to polarize itself and so to check or reverse its current. Thus prolonged immunity from disaster tends to weaken that very realization of danger which is the first condition of safety. Hence follows, in natural sequence, a relaxation of the rigorous discipline to which safety had been due; and then we have not long to wait for such accidents as Mr. Morgan would fain persuade us are to be classed as "acts of God." Again, Mr. Morgan tells us that "however we may explain it, it happens to be one of the most persistent of truths that accidents are of more frequent occurrence upon bankrupt or non-dividend paying, than upon solvent and dividend paying, railroads." Truths are very apt to be persistent when they rest upon some permanent principle; and in this case the explanation of the truth mentioned by Mr. Morgan is very obvious. The solvent and flourishing railroads can afford to pay for, and do pay for, better service than the bankrupt and decaying ones; and the better service gives better results in point of safety—leaves less opportunity for "acts of God." If Mr. Morgan's "truth" was not so persistent, or if it was persistent the other way; and if it could be shown either that the ratio of accident did not depend at all upon vigor of management, or that the more vigorous the management the greater the number of unaccountable accidents, then there would indeed be something to say for the "act-of-God" theory. It is strange that Mr. Morgan should dwell with such emphasis upon a truth that tends so directly and persistently to contradict his own thesis.

But what are the railway companies to do, it may be asked, if things naturally move in cycles, and if accidents are therefore liable to follow in ordinary course upon a period of freedom from accidents? We answer that it is for man in the maturity of his intellectual development so to take account of the action of natural laws as to provide against their injurious results. It is a law of Nature that metal expands with heat and contracts with cold, but the pendulums of clocks meant to keep accurate time are not left on that account to undergo all the vicissitudes of temperature. The voltaic cell is not left to polarize itself out of all usefulness, nor the furnace-fire to quench itself with its own ashes. In every such case, as soon as the law is observed, measures are devised, with more or less success, to introduce such compensations or rectifications as may be required; and we refuse to believe that compensatory measures of an entirely analogous kind could not be introduced in the railway service of the country to prevent safety from polarizing itself into disaster.

We quite fail to see what Mr. Morgan hopes to gain for his argument by remarking, as he does more than once, that the disasters he cites—those, namely, at Republic, at White River Junction, at Forest Hills, at Chatsworth, and at Kouts' Station—happened "from the simplest natural causes," and might have happened equally to the rudest vehicular contrivances of primeval or prehistoric man. As to the natural causes, of course they are simple enough: a bridge that is half burned away can not be expected to possess the strength of one in perfect

order; nor can one constructed on bad principles and of inferior material be expected to keep itself in position after all the strength it ever had has been jarred out of it by several years' traffic. Nothing, indeed, could be simpler than all this; but how is the responsibility of the railway companies of to-day to be lessened by the reflection that the rude ox-teams of prehistoric man were also subject to vicissitudes? No doubt a badly-made ox-cart would be liable to break down, just like a badly-built bridge of modern days; but what bearing has that on the present question? Mr. Morgan tells us of a certain Philares (by which we suspect he means *Phalaris*) who used to roast his subjects for his amusement in the interior of a brazen bull; and he says, no doubt with great truth, that the railway companies are not of this disposition, and moreover that a modern railway accident, considered as a means of cremation, is very costly—much more so than the half-cord or so of wood used for heating up the brazen bull. All very true. We quite admit that the companies would like to avoid accidents and save costs of all kinds; but we say that nothing will hold them to a determination to do so, so far as the utmost exertion of vigilance and the employment of the very best appliances can avail for the purpose, so much as the knowledge that, if their system breaks down *at any point*, they are responsible to the last dollar. We quite agree with Mr. Morgan that newspaper declamation as to the "greed" of companies is often wide of the mark and quite undeserved; but we also believe that such declamation, even when it is most out of place, is not calculated to do half as much harm as his reactionary plea for a division of responsibility for railway accidents between the companies and some occult agency wholly inaccessible to human prediction and to human control.

LITERARY NOTICES.

THE AMERICAN JOURNAL OF PSYCHOLOGY. Edited by G. STANLEY HALL, Professor of Psychology and Pedagogics in the Johns Hopkins University. Vol. I, No. 1. Baltimore, Md.: N. Murray. Pp. 206. Quarterly, $3 per year.

THIS journal is to be heartily welcomed and commended. It supplies a genuine want, and if the first number is a fair sample, its work will be well done, and a great credit to American science. The object of the journal "is to record the psychological work of a scientific as distinct from a speculative character, which has been so widely scattered as to be largely inaccessible save to a very few, and often to be overlooked by them." The journal is to consist of three parts: "*I. Original contributions of a scientific character.* These will consist partly of experimental investigations on the functions of the senses and brain, physiological time, psycho-physic law, images and their association, volition, innervation, etc.; and partly of inductive studies of instinct in animals, psychogenesis in children, and the large fields of morbid and anthropological psychology not excluding hypnotism; methods of research, which will receive special attention; and lastly, the finer anatomy of the sense-organs and the central nervous system, including the latest technical methods, and embryological, comparative, and experimental studies of both neurological structure and function; *II. Digests and reviews*, and *III. Notes, news, brief mentions, etc.*"

The number before us contains leading articles, entitled: "The Variations of the Normal Knee-Jerk and their Relation to the Activity of the Central Nervous System" (with plates), by Warren Plympton Lombard, M. D.; "Dermal Sensitiveness to Gradual Pressure-Changes," by G. Stanley Hall and Yuzero Motoro; "A Method for the Experimental Determination of the Horopter" (with plate), by Christine Ladd-Franklin; "The Psycho-Physic Law and Star Magnitudes," by Joseph Jastrow, Ph. D. In addition there are sixty pages and more of reviews of psychological literature, covering thirty-eight works reviewed—American, English, French, German—the reviews being of unusually excellent quality. Fi-

nally, there are ten pages of interesting notes, giving items of psychological importance.

Since the publication of "Mind" was commenced, no periodical has appeared of such fair promise for the promotion of psychological knowledge and inquiry. Professor G. Stanley Hall has made his mark in this department of science, and is thoroughly equipped for the work of conducting such a journal. We wish the enterprise every success, and believe that it will receive a cordial support from all those who are competent to judge of the value of a scientific pursuit of psychological study.

THE SCIENCE OF POLITICS. By WALTER THOMAS MILLS. New York: Funk & Wagnalls. 1887. Price, $1.

THIS book is not exactly what its title would seem to indicate. The author defines political science as the science of the state and also of citizenship, but the latter is the exclusive subject of this work. It does not treat of the functions of the state or of its historical evolution, but of the practical duties of the citizen, especially with regard to political parties. Hence, it is practical rather than philosophical, and for that very reason will probably interest a larger number of readers. The style is journalistic, and the book is cut up into a large number of short chapters, so that it reads like a series of newspaper articles.

The author's views on the subject of parties are, for the most part, those of the best public opinion of the country at the present time. He holds fast to the doctrine that a political party exists solely to carry into effect some recognized principle or principles which its members believe in, and consequently that when a party refuses to act on principle it has no longer any reason to be. He is no believer in the doctrine that a man must always indorse the action of his party, whether he approves it or not; and he has a clear sense of the despotism of party managers and of the mischief they often do. He shows that a party is not, like the state itself, a permanent organization, but a temporary one, and that when a party has outlived its usefulness it ought to perish and give way to a new organization that will deal with the problems of the day. He is, perhaps, a little too ready to break off from established parties because of disagreement with them on a single issue, the particular issue that he is interested in being that of prohibiting the sale of liquors. But he shows throughout his book the preference of public ends to private and partisan ones which is now happily characteristic of the best young men of America. In short, while there is little in the book that will be new to the political philosopher or the instructed statesman, there is much that will be useful to ordinary voters if they should study it.

We are sorry to find the book disfigured by a great number of misspellings, such as "weich" for which, "squarly" for squarely, "Leiber" for Lieber, and so on, some pages having two or three words misspelled. Such blunders are not creditable to either author or publisher.

THE GNOSTICS AND THEIR REMAINS, ANCIENT AND MEDIÆVAL. By C. W. KING. New York: G. P. Putnam's Sons. Pp. 466. With 15 Plates.

THE author's original work upon Gnostic remains was published about 1864, and met with strong commendation or reprehension, according as it fell in with or contradicted cherished notions. The most really complimentary criticism to his own mind was the assertion made by one reviewer that he had displayed in the work more the spirit of a Gnostic—that is, of "one addicted to knowledge"—than of a Christian. He claims to have continued to pursue his investigation with the motive thus described, of studying the subject for the sole purpose of understanding the truth. New and extremely valuable sources of information have come to his hand since the publication of the first edition, to which no previous author had access: in the shape of the tract the "Refutation of All Heresies," by an author, perhaps Origen or Hippolytus, who was intimately acquainted with the doctrines he exposed, and illustrated them by many extracts from the Gnostic literature, then copious enough; and of the "Pistis Sophia," the only one left of the once numerous Gnostic Gospels, and a most important book for his own purpose. Mr. King's especial field of research is the archæological side of the

subject, the philosophical side having, in his opinion, been satisfactorily treated by Matter ("Histoire critique du Gnosticisme," 1827), to whom the reader is referred. The history and origin of the system, its relations with other systems from which it was derived or has borrowed its rituals and its emblems, come under his purview. He begins by reviewing the great religious systems of the East, which were flourishing at the time of the promulgation of Christianity in those regions, with the influence of those systems upon the modes of thought and expression of both the missionaries of the new creed and their exponents. He cites from the words of St. Paul evidence of the previous existence of the germs of Gnosticism in the cities that were the scenes of his most important labors. Proof is brought forward that the seeds of Gnosticism were originally of Indian growth and were carried westward by the movement of Buddhism, which was planted in the dominions of the Seleucidæ and the Ptolemies "at least as early as the times of the generation following the establishment of those dynasties." Next, are considered the contributions of Egypt, which are discriminated from the real Gnostic productions, and have their distinctive characters pointed out; Mithraicism, with explanations of its alliance with Occidental Christianity; the religion of Serapis, the last of the heathen forms to fall before the power of Christianity; "Abraxas, Abraxaster, and Abraxoid gems," and their meaning; the relations of astrology, the Templars, the Rosicrucians, and the Freemasons; with observations about the origin of Mason's marks, and talismans, and amulets, which are related by their nature to this religion; "for Gnostic symbols and Gnostic formulæ gave their virtue to many of the class, being borrowed directly from the Gnosis or from the older creeds out of which the latter was constructed. Their employment, and the notions generating them, have been here described, showing the derivation of many of the mediæval examples from the Gnostic class; and by following out the same principle, it has been attempted to find a key to their cabalistic legends which may fit them better than any hitherto offered by their interpreters." The illustrations are drawn entirely from engraved stones, for the Gnostic societies erected no monuments to attract public attention. They include various types of the god Abraxas, Cnuphic and Serapic emblems, Egyptian types, Mithraic subjects, talismans, Hindoo symbols, and Mason's marks. The book promises to be of great value to the student, but can hardly be comprehended without some previous knowledge of the subject.

ELEMENTARY PSYCHOLOGY AND EDUCATION. By JOSEPH BALDWIN, of Texas. International Education Series. New York: D. Appleton & Co. Pp. 287. Price, $1.50

THIS work is intended expressly for elementary classes. The author says: "Our literature is rich in psychologies adapted to colleges and senior classes in our normal schools, but is destitute of a text-book suitable for our high schools and for the lower classes in our normal schools. The want of such a text-book is widely felt. The author has given the best years of his life to the effort to prepare such a text-book and thus meet the want. Each lesson here submitted has been given scores of times to large classes with highly satisfactory results. Short sentences in plain Anglo-Saxon is the rule. Object-lessons, bold type, outlines, study-hints, examples to work out, original analysis, original definitions, original applications, and helpful illustrations, are called into constant requisition."

The plan of the work is to deal in Introductory Lessons with Attention, Instinct, and Sensation; in Part II with the Perceptive Powers; in Part III with the Representative Powers; in Part IV with the Thought Powers; in Part V with the Feelings; and in Part VI with the Will Powers. Diagrams for the purposes of illustration are abundant. Topical analyses are made at the close of each chapter, together with Suggestive Study-Hints. The typography of the book is excellent.

BOSTON SCHOOL-KITCHEN TEXT-BOOK. By MRS. D. A. LINCOLN. Boston: Roberts Brothers. Pp. 27 + 237. Price, $1.

THE purpose of this manual is a very important one, for it aims to supply what many young women undertake the management of a home without—namely, a knowl-

edge of the proper methods of preparing and combining foods, and especially the reasons for these methods. Recipes have their place in the book, but more prominence is given to general principles—to explanations of the nature and uses of food, of the changes effected by the several modes of cooking—baking, boiling, steaming, and broiling—and to principles for adapting the diet to age, occupation, climate, and means. The practical directions include the care of the fire, and the cleaning of utensils, the names of the cuts of beef, with diagrams, the care of food before and after cooking, and laying and waiting on the table. Invalid cookery also receives attention. Tables of the cost of meats and fish, and charts showing the average composition of some common foods are given. The language is adapted to the understanding of young girls, and the book is indorsed by the Superintendent of the Boston Public Schools as being the outgrowth of practical teaching in the cooking class-rooms connected with the public schools of that city.

ANCIENT NAHUATL POETRY. Containing the Nahuatl Text of Twenty-seven Ancient Mexican Poems. With a Translation, Introduction, Notes, and Vocabulary. By DANIEL G. BRINTON. Philadelphia: D. G. Brinton. Pp. 177. Price, $3.

THE Nahuatl tongue is one of the most highly developed of American aboriginal languages, and is represented in a relatively rich literature, of which the present volume embodies perhaps, some of the most important specimens. The race who spoke it cultivated song, music, and the dance, with passionate love, and held the profession of poet in the highest honor. The poets' works were recited by themselves or by professional singers at public meetings and on festal occasions, as were those of Homer, the troubadours, and the Welsh bards. The old love of the song and the dance are continued, Dr. Brinton tells us, in the Indian villages to this day, with changed themes, but in forms which have undergone but little alteration. The more important songs were written down by the Nahuas, according to Sahagun, in their books, and from these were taught to the youth in the schools. The sound as well as the sense of the sentences and verses was also preserved by the method of writing which Dr. Brinton has described in a monograph that has been noticed in the "Monthly" as ikonomatic. By these methods, a large body of poetic chants was in existence when the Nahuatl-speaking tribes were subjugated by the Europeans. Some of them were translated into Spanish by Sahagun, and others were preserved in the original tongue; and thus they came to the knowledge of European writers. The question having been raised whether any ancient Mexican poetry is now extant, Dr. Brinton explains that his text is taken from a copy made by the late Abbé Brasseur de Bourbourg, from a manuscript volume in the library of the University of Mexico, composed of various pieces in different characters, which were attributed by the antiquary, Don José F. Ramirez, to the sixteenth and seventeenth centuries. In the editor's view they are from different sources and of different epochs. The collection includes a notice of the LX songs of the royal poet King Nezahualcoyotl, who died in 1472, with translations of four of the poems, and the text and translations of the twenty-seven songs mentioned in the title, which are of various moods. Not a line of these songs, the editor asserts, has ever before been rendered into a European tongue. The introduction includes notes on the Nahuatl national love of poetry, the status of the Nahuatl poet and his work, the themes and classes, prosody, and vocal delivery of the songs, the instrumental accompaniment, the preservation of the ancient songs, and the history of the present collection. The thanks of all students are owing to Dr. Brinton for the diligence and enthusiasm—with no little self-sacrifice, we judge—which he has displayed in bringing this aboriginal literature series to its present fulness. The publication can not be supposed to be a profitable or paying one, yet he has kept it up without discouragement and without depreciating the quality of the work. Abundant material remains in his hands for a continuation of the series, and other works of a similar character with those that have already appeared will be issued from time to time if sufficient interest is manifested to meet the cost of publishing them. We

hope that this interest will be shown, and the enterprise not allowed to become a burden to the editor.

HISTORY OF THE PACIFIC STATES OF NORTH AMERICA. By HUBERT HOWE BANCROFT. Vol. XXXII. Popular Tribunals. Vol. II. San Francisco: The History Company. New York: Frank M. Derby, Eastern agent. Pp. 772. Price, $5.

THE present volume of Mr. Bancroft's great work is devoted to the history of the second Vigilance Committee of San Francisco, or that of 1856, and is dedicated to its president, William T. Coleman, who is styled the "chief of the greatest popular tribunal the world has ever witnessed." The Vigilance Committee of 1856, while it was of similar composition and of the same character and spirit of that of 1851, rose under different circumstances, and to meet a different emergency. At the time of the earlier committee, law had not been established, but San Francisco was still the prey of ruffians who had been attracted from all quarters by the stories of the gold-diggings to which it was the gate, and who overrode all legal restrictions by brute force. In 1856 government had been organized, and might have been strong enough if it had chosen to exert itself, but was under the control of political tricksters, assisted by the roughs. Hence there was more apparent reason in 1856 in favor of the plea that reform should be sought through legal measures, and for the clear difference of opinion which existed between evidently honest and well-meaning men as to the propriety of the Vigilance Committee's existence and the justification of its measures. Hence, also, a more temperate style than the author of this history has permitted himself to use through most of his work would have been more becoming its sober purpose. The Vigilance Committee of 1856 was a movement by the vast majority of the people of San Francisco against systematic ballot-box stuffing, which made fair elections impossible and all elections burlesques, universal thievery, and political terrorism intensified by frequent murder; all tolerated and said to be encouraged by public officers who depended on such outrages to reach and hold their positions. These abuses had grown up since the former Vigilance Committee had finished its career five years before, in consequence of the easy-going citizens leaving politics to the politicians. It was called into being by the murder of James King, of William, editor of the "Bulletin," by James Casey, following close upon the murder of United States Marshall Richardson by Charles Cora, an Italian gambler. King's offense was denunciation of the wrongs, and particularly of Cora's crime, and attacks upon Casey, who had interested himself in Cora's defense. Casey was believed to be backed by prominent politicians, including Judge McGowan of one of the city courts, himself a formerly convicted bank-robber. As it seemed morally certain that these criminals would not, be punished, as others like them were not, the substantial citizens took matters into their own hands, and at a public meeting reorganized the Vigilance Committee, which had never formally surrendered its life. This committee was a public affair, the names of its members were known, its acts were open, and its proceedings governed by fixed rules. During the three months of its activity—from the middle of May to the 18th of August, 1856—it hanged four men, banished about thirty, rescued—that is, took possession of—two prisoners from the county jail, and held a judge of the Supreme Court under arrest, waiting the death or convalescence of his victim. Its proceedings were objected to, as those of the Committee of 1851 do not seem to have been, by a considerable party of good citizens, whose quality may be judged from the fact that William Tecumseh Sherman was one of them. The city authorities were against it, of course; the Governor of the State made feeble and futile attempts to suppress it, and efforts were made to embroil it with the United States authorities. In spite of all it went on with its work, and when it had done, adjourned *sine die*. It must be judged by its fruits. Seven years after King's death, the People's Reform Party were able to show in an appeal to voters which is too long to quote here, but which is given in full in the 656th and 657th pages of the volume, that San Francisco had, from being the very focus of peculation, disorder, robbery, and murder, under uninterrupted honest rule, become one of the best ordered,

safest, and most prosperous cities in the world. This was accomplished while national politics were kept out of city affairs. Then the people's party, under the pressure of a great national emergency, adopted a political resolution—and its usefulness was gone. In this simple fact lies a plain and impressive lesson, which is taught throughout the history; and for the sake of this lesson, if for no other reason, the study is a most valuable one.

SCIENCE SKETCHES. By DAVID STARR JORDAN. Chicago: A. C. McClurg & Co. Pp. 276. Price, $1.50.

PROFESSOR JORDAN presents in this volume a collection of scientific essays, some of which have appeared previously in "The Popular Science Monthly" and elsewhere, the others being addresses not before published. A majority of the papers are on fishes, the study of which has been the scientific specialty of the author. Among these are "The Story of a Salmon," "Johnny Darters," and "The Dispersion of Fresh-Water Fishes." There are also three sketches of a biographical character on Darwin, "An Eccentric Naturalist" (Rafinesque), and "A Cuban Fisherman" (Poey). The other papers comprise "The Nomenclature of American Birds," "The Story of a Stone," "An Ascent of the Matterhorn," and "The Evolution of the College Curriculum." These are all of a popular character, and written in a pleasing style, though without sacrificing scientific accuracy. A list of the author's scientific papers, numbering two hundred and fourteen, is appended.

ELEMENTS OF MODERN CHEMISTRY. By ADOLPHE WURTZ. Third American from the fifth French edition. Translated and edited by WILLIAM H. GREENE, M. D. With 132 Illustrations. Philadelphia: J. B. Lippincott Co. Pp. 770. Price, $2.50.

THE most striking feature of this book is its comprehensiveness. The natural occurrence and extraction or laboratory preparations and the properties of the elements and their compounds are described with great fullness, and enough subjects are presented to occupy an academy or college class for at least two years. Most of the theoretical matter is included in the first fifty pages, but a few topics are inserted at later points. Nearly half of the volume is devoted to the compounds of carbon. In choosing which facts of organic chemistry to present, the author was guided by "the historical importance and the theoretical and practical interest of the compounds described." In each of the three American editions, the editor has rearranged and added to the matter in order to better adapt the work for American use. "The present edition contains additional matter embracing the more important advances of chemistry in the last three years. Among the additions may be mentioned the history of the isolation of fluorine, the monoxide of silicon, the Castner sodium process, and the electrical furnace. Wherever new investigations have shown statements accepted formerly to be erroneous, corresponding corrections have been made."

DECISIVE BATTLES SINCE WATERLOO. By THOMAS W. KNOX. Illustrated. New York and London: G. P. Putnam's Sons. Pp. 477. Price, $2.50.

THIS work is designed to cover the period since 1815 in the same manner as Professor Creasy's "Fifteen Decisive Battles of the World" covered the period "from Marathon to Waterloo." The fact that Mr. Knox finds twenty-five "decisive battles" in the annals of the past seventy years, seems to indicate either that the world is not really passing out of a military into an industrial stage, as has been asserted, or that our author has been more comprehensive than discriminating. Some ground for the second alternative is given by the statement in the preface that "the book has, however, for its further purpose, the idea of presenting an outline survey of the history of the nineteenth century, considered from the point of view of its chief military events." These words describe the book better than its title, for each chapter includes, besides the account of an important battle, also a sketch of the whole campaign in which the battle occurred, and in several cases minor wars, which were marked by no battle of a decisive character, are touched upon in order to give continuity to the record. The first battle described is that of Ayacucho, in 1824, which terminated

the Spanish rule in South America. The battles of Prome, in Burmah, and of Staoueli, in Algiers, and the siege of Silistria, on the Danube, are among the less known operations which are included. Four battles of our civil war are ranked as decisive, viz., that between the Monitor and the Merrimac, Gettysburg, the capture of Vicksburg, and Five Forks; two of the Franco-Prussian war, Gravelotte and Sedan; and two recent British disasters in Egypt, El Obeid, and the fall of Khartoum. The author partly disarms criticism as to his selection, by saying that it is unlikely that any unanimity of opinion could be found among historical students of the present day on this subject. Mr. Knox is best known as a writer of juvenile books of travel and biography, and his style in this volume is popular, displaying much of the picturesqueness which fascinates his younger readers. A general statement of his sources of information is given in the preface, but there are no specific references to authorities in the text. The volume has no index.

United States Commission of Fish and Fisheries. Part XIII. Report of the Commissioner for 1885. Washington: Government Printing-Office. Pp. 112 + 1108.

This bulky volume testifies to the industry of the Fish Commission during 1885. The report gives a general survey of the work of the year, and to it are appended thirteen reports of steamers and stations, including one on the thermometers used by the Commission, by Dr. J. H. Kidder, and twelve other papers on special topics. Among the latter is an account, by Captain J. W. Collins, of the fishing-grounds examined during a cruise along the coast of the South Atlantic States and in the Gulf of Mexico. This paper contains much information in regard to the methods and results of the sponge, turtle, and other fisheries of Key West and the fisheries of Western Florida, in which the red snapper, pompano, sheep's-head, Spanish mackerel, mullet, etc., are caught. Under the head of scientific investigation are two papers on the development of the cetaceæ and of osseous fishes, by John A. Ryder; one on the decapod crustacea of the Albatross dredgings, by Sidney I. Smith; one on the *Annelida chætopoda* from Eastport, Maine, by H. E. Webster and James E. Benedict, and another by John Murray and A. Renard, read before the Royal Society of Edinburgh, on the nomenclature, origin, and distribution of deep-sea deposits. There is a catalogue by David S. Johnson, supplementary to the "Synopsis of the Fishes of North America," issued in 1883, and comprising additions and corrections accumulated during 1883 and 1884, and also a list, with descriptions, of patents of 1882–'84 relating to fish and fisheries, illustrated with one hundred and fifty plates. Many of the other papers are copiously illustrated.

Second Annual Report of the School of Expression, Boston: S. S. Curry, Dean. Pp. 3.

The School of Expression has grown out of the work of the School of Oratory which was opened at Boston University some fourteen years ago. Its aim is not merely to educate one phase of the delivery, but to include training for the complete control of the body and the whole mechanism used in speech, and also to give practical discipline of the imaginative, sympathetic, logical, and dramatic instincts. The first endeavor is to secure correct intellectual, emotional, and volitional action in all kinds of reading and speaking. The mechanism used in speech is developed, and ease, agility, and precision of action without waste of the vital force are sought through careful and thorough vocal training; while other exercises look to the development of poise, ease, precision, and harmony, flexibility, and strength in the whole organism. The theory of the school is, in short, "to secure control of every agent and develop its distinct function in expression."

Proceedings of the Biological Society of Washington. Vol. III., July 1, 1884, to February 6, 1886. Pp. 180.

Besides the journals of the several meetings of the society, this volume contains the annual presidential addresses of Dr. C. A. White (1883) on "The Application of Biology to Geological History," and of G. Brown Goode (1886) on "The Beginnings of Natural History in America." Dr. White elucidates, in opposition to the European theory of the synchronous character of similar de-

posits of fossils, the idea of homotaxy, as proposed by Professor Huxley to express the existence of close biological relationship between formations in different parts of the world which might not, or could not, have been contemporaneously deposited. Dr. Goode's address we have found extremely interesting. It gives a clear account of the progress of observation and the growth of science in this country from the first observations of Oviedo y Valdes in 1525, and Thomas Harriott, of Virginia, in 1590, through a considerable list of original contributors, to the end of the last century. The men whose names are mentioned, the author says, "were the intellectual ancestors of the naturalists of to-day." The volume also contains lists additional and supplementary to those heretofore published, of flora of Washington and vicinity.

UNITED STATES DEPARTMENT OF AGRICULTURE. REPORT OF THE ENTOMOLOGIST FOR 1886. By C. V. Riley. Pp. 144, with Plates. REPORTS OF EXPERIMENTS WITH VARIOUS INSECTICIDE SUBSTANCES. Pp. 34. OUR SHADE TREES AND THEIR INSECT DEFOLIATORS. By C. V. RILEY. Pp. 69. Washington: Government Printing-Office.

BESIDES the general review of the work of his bureau by the Entomologist, the "Report" contains papers on the "Cottony Cushion Scale," "Buffalo Gnats," the "Fall Web-worm," and "Joint-worms"; each paper embodying a description of the insect, an account of its depredations, and suggestions of remedies. A paper on "Silk Culture" represents the prospects of this business in the United States as not yet hopeful, but speaks well of the Osage orange as a food-plant for the silk-worm. Reports of agents are given upon various insects affecting small grains and grasses; and the last paper is a "Report on Experiments in Agriculture." The experiments with insecticide substances of which the second pamphlet gives accounts, were directed chiefly to insects affecting garden-crops, and were performed at Ames, Iowa, Lafayette, Indiana, and Trenton, New Jersey, with ice-water, chemical solutions, and vegetable decoctions. They are described in detail. The insect defoliators of shade-trees whose cases are considered in the third pamphlet are the imported elm-leaf beetle, the bag-worm, the white-marked tussock-moth, and the fall web-worm. The information given is full. As "one simple preventive remedy for all," spraying the trees with arsenical mixtures in the middle of May, and once or twice at intervals of a fortnight later in the season, is recommended.

MODERN AMERICAN METHODS OF COPPER-SMELTING. By EDWARD D. PETERS, Jr. Illustrated. New York: Scientific Publishing Co. Pp. 342.

IT has been the intention of the author of this book to confine what he wrote, with few exceptions, to his own experience, and to present no more of the theory of the subject than is essential for understanding practical operations. A feature of the work is the estimates of cost, both of plant and of operating, which the author has presented in considerable detail. In order to keep the volume within moderate size, the so-called "wet methods" have been excluded. After a description of the methods of copper-assaying practiced in this country, he describes the several ways of roasting lump-ore and matte, recommending for the building of roasting-stalls "slag-brick" molded in sand. The calcining of fine ore and matte is then treated, and a short chapter is given to the chemistry of the calcining process. The smelting of copper comes next in order, and this naturally falls into the divisions of smelting in blast-furnaces and in reverberatory furnaces. Dr. Peters maintains the general excellence of the American form of the blast-furnace process, while admitting the necessity of using reverberatories for certain portions of the matte concentration in many cases. A few pages on separating the precious metals from copper, and on Bessemerizing copper mattes are added.

THE CONCEPTION OF LOVE IN SOME AMERICAN LANGUAGES. By DANIEL G. BRINTON. Philadelphia: McCalla & Stavely. Pp. 18.

PREMISING that the words which denote love picture the heart of those who use them, the author has studied their history and derivation in the American languages as furnishing evidence of the development of the altruistic principle among the races, and as illustrating the wonderful parallelism

which everywhere presents itself in the operations of the human mind. The most prominent words relating to love in the Aryan languages may, in the author's view, be traced back to one or two ruling ideas—one intimating a similarity or likeness between the persons loving, and the other a wish or desire; the former conveying the notion that the feeling is mutual, the latter that it is stronger on one side than on the other. The subject is studied from this point of view in the Algonquin, Nahuatl, Maya, Qquichua, and Tapi-Guarani languages.

THE RELATIONS OF GEOLOGY AND AGRICULTURE. By W. J. McGEE. Washington: Judd & Detweiler.

THIS paper is an address which was delivered at the meeting of the Iowa State Horticultural Society in 1882. The author's object is to point out the importance of applying geologic principles to the investigation of the soil. It is premised that the soils of the earth are immediately derived, through mechanical and chemical action, from the underlying deposits forming the subsoil—pre-eminently the agencies with which the geologist has to deal. The application of the principle is illustrated by citations from the author's studies of the drift of Iowa.

AN INQUIRY INTO THE TRANSMISSION OF INFECTIOUS DISEASE THROUGH THE MEDIUM OF RAGS. By CHARLES F. WITHINGTON, M. D. Pp. 69.

THE author concludes that small-pox has been transmitted through the medium of rags, to an extent which though not great, is sufficient to show that there is real danger in the matter; and that the source of the infection is more frequently domestic than foreign rags. Among the rarer means whereby cholera is transmitted are textile fabrics infected with choleraic discharges. A solitary case is reported, but not fully accredited, of transmission by paper rags; if substantiated, it also will be an offense by domestic rags. Cases have occurred of an epidemic affection of anthrax called "rag-sorter's disease" caused by handling rags. Authenticated cases have not been found in which the other infectious diseases have been transmitted through rags; and there is no evidence to show that rag-sorters as a class are essentially less healthy than other persons engaged in indoor operations. Still precaution should be taken against possible danger from rags coming from epidemically infected places, and paper-mills should have means for purifying their rags, and ventilating means for guarding against dust-poisoning; and whatever precautions are used should be applied as much to domestic as to foreign rags.

BULLETIN OF THE IOWA AGRICULTURAL COLLEGE, FROM THE BOTANICAL DEPARTMENT. BYRON D. HALSTED, Sc. D., Professor of Botany.

THE study of botany is pursued in regular course in the college beginning with the second half of the freshman year. The instruction consists of observations of actual plants assisted by Gray's text-books, beginning with leaves and flowers, their forms and arrangement. The studies in the sophomore year are taken up before the opening of spring, upon branches and buds. During the spring, each student prepares an herbarium of fifty species, collected and determined by himself. The work is continued during the year in morphology and the general characteristics of plants; and the pupils are exercised in special topics of research in which they prepare papers from their own observations. In the junior year cryptogams and vegetable physiology are studied; a course in applied botany is given, and three hours a week of laboratory work are provided for. A variety of experiments are recorded, and numerous special papers, mostly brief, are published in the second part of the "Bulletin."

THE BEST READING. THIRD SERIES. A Priced and Classified Bibliography, for Easy Reference, of the more Important English and American Publications for the five years ending December 1, 1886. Edited by LYNDS E. JONES. New York and London: G. P. Putnam's Sons. Pp. 108. Price, $1.

EVERY one who knows the first and second series of this work will eagerly welcome the present volume. To those who have not used the preceding volumes, it may be said that no bookseller, no one who buys books for his own or for a public library, and no one who reads systematically,

or has occasion to direct the reading of others, can afford to be without "The Best Reading." An explanation of the letters and stars used to indicate the character of books should have been inserted in this volume.

WINTER: FROM THE JOURNAL OF HENRY D. THOREAU. Edited by H. G. O. BLAKE. Boston: Houghton, Mifflin & Co. Pp. 439. Price, $1.50.

THIS volume is made up of passages entered by Thoreau in his journal during the winter months from 1850 to 1860, with occasional entries of earlier dates. The scenes alluded to are along the Concord River and about Lake Walden, with occasional visits to other places. These pages reveal how much of interest a lover of Nature can find in the fields and waters during the season when Nature is commonly said to be asleep, and are interspersed with reflections suggested by winter objects.

ASTRONOMICAL REVELATIONS. New York: Edward Dexter. Pp. 62. Half morocco. Price, $2.

THIS is a contribution to theoretical astronomy, in which the author confidently claims that "the true physical causes of the precession of the equinoctial points, the apparent secular acceleration of the moon's mean motion, the decrease in the obliquity of the ecliptic, the apparent aberration of the stars, and the apparent nutation of the earth's axis, are now for the first time made known and explained." A theory of the physical nature of the fixed stars is added, which regards them as reflections from the diversified surface of a solid shell inclosing the solar system.

STORIES OF OUR COUNTRY. Historical Series, Book III, Part I. Compiled and Arranged by JAMES JOHONNOT. Illustrated. New York: D. Appleton & Co. Pp. 207. Price, 47 cents.

THE design of this book is clearly expressed in the preface: "By the use of this little work, the pupil has all the aids to reading which characterize ordinary reading-books—lessons for practice, variety in style, and all the necessities of elementary elocution. Besides these, he gets all the interest that the story excites, the knowledge which it unfolds, and the sentiment which it imparts, and the reading-lesson becomes a potent force in mental and moral development." The selections relate to the early explorations of America, to colonial times, and the Revolution, with a few stories of the War of 1812 and the Mexican War. They have an intensely vivid character, which is heightened by the spirited illustrations. Such a book as this can not fail to fascinate the pupils for whom it is prepared, and turn the lesson which was a hated drudgery with the old-fashioned reading-books into a delightful exercise.

SECOND ANNUAL REPORT OF THE FOREST COMMISSION OF THE STATE OF NEW YORK. 1886. Albany. Pp. 177.

THE secretary of the commission, Mr. A. L. Train, who prepared this report, states in a prefatory note that as the commission has not been supplied with funds for investigations, experiments, surveys, etc., information obtainable only by such means can not be expected in the report. He has accordingly presented an account of what work the commission has been able to do since its appointment, together with a compilation of facts and opinions bearing on the subject of forestry, which might enlist "the aid of the people more earnestly in the important effort to maintain the remnant of the forest area still left to them." The commission has already secured the payment into the State treasury of $14,057.09 for trespasses, and for timber illegally cut on State lands, and has stopped, probably permanently, these illegal practices. Another result of its work is the suppression of forest fires during the past year.

COTTAGE RESIDENCES. By A. J. DOWNING. Edited by GEORGE E. HARNEY. Illustrated. New York: John Wiley & Sons. Pp. 261.

THE original wide scope, refined taste, and practical character of this work made it of lasting value, and its worth was increased by the revision and enlargement which were given to its fifth edition in 1873. The guiding principle of the author was to combine the beauty of sentiment and of propriety with fitness, and with each design is given a suggestion as to the character of the natural surroundings to which it is best

adapted, together with directions and diagrams for laying out ornamental grounds, kitchen-gardens, and orchards. The revision of the book comprised the modifying of the estimates of cost to agree with changed prices of labor and materials, the substitution of new lists of plants and trees for those formerly given, together with the addition of twelve new designs for buildings, some further hints on gardens and grounds, and remarks on the employment of architects and contractors.

MANUAL OF CLINICAL DIAGNOSIS. By OTTO SEIFERT AND FRIEDRICH MÜLLER. Translated from the third (revised) edition by WILLIAM B. CANFIELD. With Sixty Illustrations. New York: G. P. Putnam's Sons. Pp. 173. Price, $1.25.

THIS manual comprises concise directions for the various clinical examinations which yield the data for medical diagnosis. It contains, also, facts and figures which the physician should always have available, yet which are too numerous to be remembered correctly, and too widely scattered through books and periodicals to be readily referred to. The favor with which the book has been received in Germany has led to this translation.

AN extended and richly illustrated work on "The Fishes of North America" is announced by Mr. William C. Harris, editor of the "American Angler," who has spent five years in collecting the material for it. Many months of this time were spent on selected fishing waters, with a skilled artist in company with the author, who, working upon the shore or in the stern of the boat, painted the portraits of the specimens immediately after they were caught, while the lively coloring and evanescent sheen were still upon them. The portraits are given in an upright position, as in the act of swimming, with all the markings, even to the exact number of spines in the fins, faithfully reproduced. The publication will be issued in monthly parts, with pages twelve by seventeen inches in size, which will contain each: Two portraits of fishes, colored as in life; scientific classification and description; local names and habitat; when and where caught; method of capture; tackle and lures used; and striking incidents of capture. The work will be issued in forty parts, containing the portraits, etc., of eighty fishes. Price, $1.50 a number.

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POPULAR MISCELLANY.

Mr. Lockyer's Theory of "The Cosmos."—Mr. Lockyer has presented, in a paper to the Royal Society on the "Spectra of Meteorites," a new hypothesis concerning the origin and nature of the stars and other celestial bodies. Among the fundamental propositions of his theory are those that all self-luminous bodies in the celestial spaces are composed of meteorites, or masses of meteoric vapor, produced by heat brought about by condensation of meteor swarms due to gravity; that the spectra of all bodies depend upon the heat of the meteorites, produced by collisions, and the average space between the meteorites in the swarm, or in the case of consolidated swarms, upon the time which has elapsed since complete vaporization; that the existing distinction between stars, comets, and nebulæ rests on no physical basis; and that the main factor in the various spectra produced is the ratio of the interspaces between the meteorites to their incandescent surfaces. These, with other propositions of more detailed and specific character, are sustained by results of spectroscopic examinations of meteorites and of various substances, which are described particularly. Experiments prosecuted for fourteen years have shown that the luminous phenomena manifested by the several classes of heavenly bodies can be reproduced in the laboratory by subjecting meteorites, as far as possible, to conditions similar to those assumed by the hypothesis to exist in space. Thus, the reproduction of the spectrum of the sun by the fusion of meteorites in the voltaic arc accords with the supposition that it is the result of the condensation to the point of complete volatilization of an originally sparse swarm of meteorites. The spectra of comets when near the sun give the lines of a meteoric body glowing in a dense atmosphere given off by itself when highly heated; while at their greatest observed distances from the sun their spectra are identical with those of the nebulæ, which are supposed by the hypothesis to be "closely associated with a meteorite glowing very gently in a very tenuous atmosphere given off by itself." Hence nebulæ are supposed to be sparse clusters of associated meteorites, and their luminous phenomena to be due to the glow of gases which result from collisions between the individuals of the group. Comets are nebulæ whose proper motions have brought them within the range of the sun's attraction; but when outside of his more immediate influence they exhibit no phenomena which are not also exhibited by nebulæ. The next stage of approximation is exhibited by stars designated as of Class IIIa, and is due to the attraction of gravity among the individual meteorites of the swarm; and the succeeding stages are indicated by the increasing complexity of the spectra, whether of the meteorite itself rendered incandescent by collision of the vapors by which it is immediately surrounded, or of the general interspace between me-

teorite and meteorite. At this point the direct evidence of the spectroscope fails us. The force of gravity which has drawn the meteorites gradually together must still continue to operate, but as its operations become more intense the collisions will become more frequent, until at last the meteorites are completely volatilized by the heat evolved, and in that case the star becomes a mass of incandescent vapor at a transcendental temperature. We know that such stars exist, but we can not produce their spectra in the laboratory because we have no means of obtaining the temperature required. The condensation is now complete, and the highest temperature capable of being evolved by the forces at work has been attained. When gravity has resulted in the complete volatilization of the gravitating bodies its power is exhausted, and the process of cooling must thenceforth set in. This stage is exhibited in the stars of Class II, of which our sun is the most familiar example. The stars in Vogel's Class III*b* once more exhibit spectra capable of approximate reproduction in the laboratory, and thus show that they have returned to a temperature no longer transcendental. The last stage of all is that of stars, or bodies associated with the stars, so cool as no longer to be incandescent. The spectroscope tells us nothing of them, but there are good evidences of their existence. Is this the end? We can not say so with any confidence. We have no right to say that collisions can not occur between the larger bodies as well as between the meteorites. Then "the cycle of the universe would be complete, and we might say of the Cosmos as the geologist Hutton said of the earth—that it exhibited no trace of a beginning, and no evidence of an end. This, however, is pure speculation."

Antiquity of North American Flora.—Reasons are adduced by Mr. A. T. Drummond, in his discussion of the distribution of British North American plants, for supposing that America was the starting-point of that phase of the vegetation which, in its later development, has become the flora of to-day. The first undoubted evidences of this flora, on any considerable scale, are found in the Leda clays of the Ottawa Valley. The Eocene flora resembles, not so much the Eocene as the later Miocene of Europe. Seeing that the Eocene and Upper Cretaceous of North America, in the resemblance of their flora to that of northern temperate America of to-day, are older than the European Cretaceous and Eocene, that it was only in later epochs in Europe that the generic identity with North American plants became so very distinctly marked, and that in Europe many of the genera of the Pliocene identical with those of to-day have since become extinct, "there seems a possible presumption," says the author, "quite apart from that derivable from their present range, that some of these identical European and American plants may be older in America, and being northern temperate in range may have originated in northern temperate America."

The Peabody Museum.—The latest—the twentieth—annual report of the Peabody Museum of American Archæology and Ethnology records the complete affiliation of that institution with Harvard University by the installation of its curator, Dr. F. W. Putnam, as professor there. This position imposes no duties which the curator of the museum has not already performed, they consisting only of the delivery of one or more courses of lectures annually; but it brings the museum more closely into the general system of the university. The archæological work which the museum has in hand includes explorations in Nicaragua and Costa Rica through the co-operation of Dr. Earl Flint, in the course of which many relics, including some of jade, have been recovered, and human foot-prints have been found in volcanic tufa sixteen feet below the surface; continued explorations by Dr. C. C. Abbott, in New Jersey, which have yielded, in fragments of human skeletons associated with the stone implements in the glacial gravel, the earliest record of man on the Atlantic coast; the explorations of the shell-heaps of Maine, under Dr. Putnam's personal supervision, which have brought to light many interesting facts relative to the early occupation of New England by man; the ethnological researches of Miss Alice C. Fletcher among the Omaha and Sioux Indians, which is growing into a his-

tory of the tribes, with a description of their social and religious customs; and the explorations in the mounds and burial places of the Scioto and Little Miami Valleys of Ohio —the most extensive and systematic of the museum's explorations—which have yielded extremely rich results in illustrating the life and customs and rituals of the people to whom they appertained. To these may be added the decipherment and translation by Mrs. Zelia Nuttall of a number of the Mexican codices and inscriptions.

The Scientific Privileges of Country Boys.—"Nor is the study of natural things, and the making of discoveries," says Professor O. P. Hay, in a paper on "The Amphibians and Reptiles of Indiana," "the exclusive privilege of those who have received a scientific training. There is not a farmer boy in Indiana who may not make solid contributions to science if he will but use his opportunities. Persons who live in the country are in direct contact with Nature. They see a thousand things that the naturalist would delight to see, and yet may never be permitted to behold. The time of coming and going of the various species of birds; their curious habits, as shown in nest-building and obtaining food; and the occurrence here and there of rare species of various animals, are examples of matters which all may observe and report, and which science needs to know."

Rich Men's Duties to Themselves.—While the value of wealth as an alleviator of suffering and a promoter of worthy public objects is strongly appreciated by many who possess it, says Lester F. Ward in "The Forum," "its value as a direct means of intellectual and moral culture is rarely discerned by this class. Many rich people are fully alive to their duty toward others, and at the same time apparently devoid of a sense of their duty toward themselves. The function of wealth, in affording leisure for culture and for thorough, painstaking work in any field of progressive labor, has always been and always must be a far more important one than that of furnishing temporary relief to suffering humanity. Without leisure, Humboldt could not have explored all the realms of Nature, and given the world an intelligible cosmos. Without immunity from care, Newton could not have found out and unfolded to his age and ours the true nature of the universe. Without leisure and resources, Darwin could not have fathomed the mysteries of life and solved the great problem of being. Civilization, with all its mechanical accessories and blessings, is the product of calm deliberation and patiently-wrought results. The inventions that underlie it were impossible until the principles of Nature upon which they rest had been established, and this has in most cases been the result of prolonged researches made for truth's sake alone. . . . This scientific work, this search for truth for its own sake, can only be successfully prosecuted when the means of subsistence are made to be not in the least dependent upon it. . . . The so-called men of leisure, who have accomplished these good results, have really been the most industrious of all men. Leisure, in this sense, merely means relief from the necessity of performing statical work, in order to be able to perform dynamic work. . . . But how few understand it in this sense!"

New Economical Plants.—The directors of the Saháranpur Gardens, India, are cultivating a number of new plants, for acclimitization. Among them is the *Acacia Senegal*, which, besides yielding the best gum-arabic, furnishes a reddish-brown wood which takes on a fine polish, and is used for weavers' shuttles. The *Cedula adorata*, or West Indian cedar, has a light wood of a mahogany color, even-grained, easily worked, and fragrant—the wood from which Havana cigar-boxes are made. *Cencheris catharticus* is a much-valued fodder-plant, which grows in sandy-desert tracts. It is the *Tuart* of Australia, a tree of magnificent proportions, which furnishes most excellent hard-wood timber. The *Myricas*, or wax-myrtles, of North and South America, are cultivated for the waxy exudations on their fruits, from which the wax is separated by boiling and skimming. The fruits of the *Sapindus saponaria*, or West Indian soap-berry, contain a large quantity of a saponaceous matter, which is used for washing clothes. The hard, round, black seeds are worn as beads for necklaces.

How to be a Good Nurse.—Six things, says a doctor writing on the subject, are necessary to a good nurse: Strong, equable health; sound nerve; minute observation; a retentive memory; habits of neatness and cleanliness; and a calm, collected mind. A nurse must never disregard her health, because it is essential to her own well-being, and because, too, attendants on the sick should always be cheerful and hopeful. Sound nerve is often a matter of training, but its root lies in unselfishness. Any one who, in an accident or operation, forgets self in the desire to aid others, will not be troubled by trembling or fainting. The faculties of observation and retentiveness of memory can be developed by having interest in the work strong enough to make the nurse careful and patient in her observations. A calm mind is generally the result of organization. If a nurse has arranged her day's work beforehand, if she keeps everything punctually to this arrangement, and if everything needful is neatly disposed, she is not likely to be discovered in bustle and confusion at any time. The nurse should, furthermore, be mindful that she is under the doctor, and should respect and obey his directions even if she differs in opinion from him. It is extremely important that those who are sick and suffering should be treated with unfailing gentleness and patience; nothing can ever excuse a nurse for losing her temper with her patient. No duty is too little or trifling for her attention, and no work that is for the good of the patient can be degrading. It is further a good rule never to approach a case fasting; but always to have a good meal before going on duty.

Notes about Maple-Sugar.—According to a pamphlet on "Maple-Sugar and the Sugar Bush," by Mr. A. J. Cook, trees growing on high, gravelly soil are supposed to supply richer sap, while those on clay or muck yield more abundantly. Exposure to the open sunlight is favorable to a good yield. Concerning the influence of the preceding season on the supply, opinions differ. Vermont sugar-makers believe that an open winter is conducive to a good flow and richness of sap, while those of Indiana and Michigan think the reverse. North and west winds and clear skies are favorable, while east and south winds and the approach of a storm are unfavorable. An increase in the amount and richness of the sap has been noticed after a rain. A layer of snow or frozen ground over the roots of the tree is thought to be conducive to a bountiful yield. The deeper the bore of the tap, the longer the sap will continue to run; but a small hole gives nearly as much sap as a large one, with considerably less injury to the tree. While the sugar-maple is the best for sugar, the other maples are often tapped; but it is an objectionable feature in them that the buds start earlier, causing an increase in the amount of inverse sugar and other changes that give a bitter taste. The average yield per tree is probably two or three pounds, but single trees have been told of which gave thirty or forty pounds. Some sixteen or twenty quarts of sap are required to give a pound of sugar. Mr. Cook estimates the profits of his own sugar-bush at ten per cent on the capital invested, with no risk; and the business promises to become more and more a source of profit each year. For, "the maple-sugar industry is so limited by the very condition of things, and its product is so incomparably superior to all other like products, that we need fear no dangerous antagonism, no impoverishing competition. We have, and can always keep, the monopoly." The care and extension of maple-sugar plantations are therefore advised.

Curiosities of Guessing.—Some curious facts bearing on the "Eccentricities of Guessing" were communicated to the American Association by Professor T. C. Mendenhall. The author had formed a standard probability curve which could be applied to any form of guessing, and which represented the law that governed the occurrence and recurrence of purely accidental things. This standard was seldom deviated from to any considerable extent. He had frequently tested the accuracy of the probability curve by experiment. A large number of persons guessed at the number of nails of various sizes contained in a carboy. The lowest guess was 43; the highest between 3,000,000 and 4,000,000. Eight guesses came within one of the actual number, six falling

short, and two exceeding it, while a vast majority came within a few hundred of it. It was 2,551. Many terminated their guesses with the figure 7; then 3, then 9 came in the order of preference. Odd numbers occurred three fourths of the time; and the number of the year was frequently chosen.

Electric Tractive Adhesion.—Mr. Elias E. Ries exhibited, in the American Association, his method of using the electric current for increasing the tractive adhesion of railway-motors and other rolling contacts. The electric conductors are connected with the driving-wheels of the motor-car by means of contact-brushes in such a manner that the rails situated between two pairs of wheels complete the electric circuit. This circuit moves along with the motor-car, which also carries the source of current, and the amount of current flowing through the circuit is directly under the control of the driver. The track-rails in front and rear of the car are at all times free from current which is confined to that part of the track between the driving-wheels. The author claims that the tractive force can be increased by this system nearly two hundred per cent, and the motor can be made capable of propelling itself with ease up a forty-per-cent grade.

Origin of Bright's Disease.—The cause of Bright's disease, according to Dr. J. Milner Fothergill, is a tendency of the system to revert to the excretion of solid uric acid, after the manner of the cold-blooded animals and birds, instead of the soluble urea, which is the characteristic excretion of the higher animals. When the uric-acid formation is established, the substance is either gradually deposited in the body—in the articular cartilages by preference—or is cast out by the kidneys, with irritation of those organs. With this effect are often associated "insufficient" liver and migrainous neurotic affections which are growing more common among town populations. "With an insufficient liver, a meat dietary, and insufficient oxidation, the town dweller is the subject, more than all others, of the uric-acid formation, with all its varied consequences. . . . The effect of town life is to produce a distinct retrogression to a smaller, darker, precocious race of less potentialities than the rustic population. Precocity is seen in early puberty, but reproduction is impaired. . . . The retrocedent race perishes either by sterility in the females, or their sparse progeny succumb to the diseases of childhood. . . . This retrocedent race are the possessors of congenitally insufficient livers, and as a consequence are the victims of the uric-acid formation." And Bright's disease is especially their disease.

Plants with Insect-guards.—W. J. Beale and C. E. St. John presented, in the American Association, a study of the hairs in *Silphium perfoliatum* and *Depsocus lacinotus* in relation to insects. The upper surface of the leaf in these plants, near the apex, is thickly set with small hairs, all of which point toward the tip. Similar hairs were found all along the mid-veins, side-veins, and veinlets of the upper surfaces of the leaf. The cavities formed by the perfoliate leaves are very small and hold but little water. They are very full after any rain or heavy dew. These cups do not seem to serve any purpose as insect-catchers, as only a few insects were caught during two weeks in which the plants were watched, and they could afford but little nutrition. It seems more probable to the authors that the object of the cups with their water is to protect the plant from crawling insects, and this is done most effectually.

His own Publisher.—Mr. Ruskin has adopted a plan of his own for producing his books. He is his own publisher, having simply an agent to attend to the business, who works for a commission, and charges fixed prices for books sold, to all buyers alike. His "Establishment" is, as the angry booksellers once contemptuously asserted, "in the middle of a country field"—that is, in a retired country house, "Sunnyside," at Orpington. At first, he would allow of no discount or abatement to the trade, but charged them the same as private purchasers, expecting them to add their profit openly. This set the booksellers against him, and they refused to handle his works. The public, nevertheless, found him out, came to him and bought his books, and he enjoyed a good income and a growing busi-

ness in spite of his violation of all the accepted rules of the trade. Latterly, he has relaxed his rule, in consequence of representations made to him from every side, and allowed the trade a discount of from ten to fifteen per cent; so that now the larger part of his business is done through the shops. He also set his head against advertising, and has consequently been boycotted by the press, and made the victim of a "complete conspiracy of silence" during the last fifteen years. The "Times" is glad to publish his stray letters now and then, but ignores his books; and the professed literary journals "have not noticed anything that one of the foremost literary men of the time has written since 1872. The secret of Mr. Ruskin's success in spite of his hostility is told by his publishing agent: "In the long run a good article is sure to fetch a good price. Mr. Ruskin is a good writer, and the public has found out the fact. As for my own part, I have simply had to see that the 'get up' was correspondingly good."

How to take a Turkish Bath.—Persons who are timid about taking the Turkish bath, or are afraid of exposing themselves to extremes of temperature, may find security in observing a few simple rules. The bather should first go to a room a little above blood-heat, and remain there until the surface of the body is moist and reddened. If the skin does not begin to assume this condition in about ten minutes, he should have himself given a warm-water-and-towel rubbing. When perspiration has fairly begun, and the skin is moist from head to foot, the bather should have a little cold water thrown upon the feet and legs, and should afterward go into a room of somewhat higher temperature, where he should lie or sit down, with his eyes closed, if that is agreeable. But he should not remain in any of the hot rooms longer than half an hour, nor so long if the ventilation is imperfect or the air impure. He should be "finished" with an affusion of slightly cold water, and should exercise extreme caution about taking the douche or plunge, which it is always safe to omit. He may drink water, soda-water, or lemonade in the bath, and a small cup of coffee or tea in the cooling-room, where he should lie or sit down, wrapped in towels, until the perspiration has subsided; but should not remain so long as to become cold. He should afterward dry the skin briskly with a rough towel, and dress quickly. A short, pleasant walk, followed by a light meal with agreeable conversation and cheerful surroundings, are desirable after the bath.

Roundabout Heating.—We often hear of devices by which the application of force is to be greatly simplified and cheapened; a favorite scheme of the present time is to make the application in the shape of electricity. The projectors of such schemes forget or do not know that the effect they desire to produce must be obtained from the consumption of force in some other form equivalent to the power they will develop, with a considerable excess that is destined to go to waste. The real working of these devices is illustrated by Professor W. M. Williams in the case of a proposed foot-warmer for railway-cars, which is to be heated by applying the electric current to acetate of soda. The foot-warmers of this substance already in use are heated by immersing them in hot water, when they may be kept warm for several hours. "Instead of such direct heating, we are first to heat a boiler, losing heat in the production of steam, losing more in working the steam-engine, very much more in the dynamo, and more again in transmission. The cost of such electric heating would be at least twenty times as great as direct heating, not to mention cost of apparatus."

Oral and Text-Book Instruction.—The difference between the oral and the so-called text-book method has been defined by Dr. William T. Harris in a paper on the "Teaching of Natural Science in the Public Schools," which is published in Bardeen's "School-Room Classics." In the oral method the teacher is the general source of information; in the other, the pupil is sent to the text-book. In neither is cramming with mere words considered good teaching; and yet, with a poor teacher, it may happen under either. The excellence of the oral method should be its freedom from stiffness and pedantry, and its drawing out of

the pupil to self-activity in a natural manner. Its abuse happens when the subject is presented in a confused manner, or scientific precision is lost by using too familiar language or by too much pouring-in without exercising the pupil by making him do the reciting and explanation. The excellence of the text-book method consists in getting the pupil to work instead of working for him; in teaching him how to study for himself, and to overcome difficulties by himself, instead of solving them for him. Unless the teacher knows this and directs all his efforts to achieve this end, very great abuses creep in. Thus it may happen that the teacher requires the pupil merely to memorize the words of the book, and does not insist upon any clear understanding of it. Indolent teachers lean upon the text-book and neglect to perform their own part of the recitation. But in the hands of the good teacher the text-book is a powerful instrument to secure industry, precision, accuracy, and self-help on the part of the pupil.

NOTES.

THE theories expressed in the "Monthly" by Mr. Eaton and Mr. Gouinlock, that constriction of the blood-vessels of the head by tight hats is a chief cause of baldness, have been reviewed by Professor T. Wesley Mills, who only partly accepts them, and holds that the principal root of the trouble is in nervous strain. Men, by their position and more intense responsibilities, are more liable to this disorder than women, because they are more subject to mental overwork. "Baldness," this author concludes, "is one more of the many warnings of our day—one of Nature's protests against the irregular and excessive activity maintained in this restless age."

"THERE is no reasonable doubt," says J. L. Kaine, of Milwaukee, in a paper on the "Condition of Health in Cities," "that if the public would apply such laws as sanitarians are agreed about, there would be an immense saving in human life and in the time and money now lost through sickness. The conditions of health in cities involve only fresh air and wholesome water. Given these, which a man can not provide for himself, and given the exercise of some control over the character of the food-supply, a man can take care of other conditions himself—he can keep a clean skin and be temperate and take exercise."

THE Medico-Legal Society of New York offers the Elliott F. Shepard prize of $100 for the best essay on any subject within the domain of medical jurisprudence or forensic medicine, with second and third prizes of $75 and $50, respectively, for the next best essays. The competition is open to all students in the subject throughout the world, upon the condition of their becoming members of the society. It will close on the 1st of April, 1888. Papers designed for it should be sent to the president of the society, New York.

MONOTONOUS, continuous sounds are recommended by various persons as promotive of sleep. Any one who has experienced the murmur of the insect and leaf life of a forest knows how quieting it is. So the purling of the waters, the humming of a hive of bees, the buzz of a spinning-wheel, and the murmur of a distant factory, all act as lullabies. And Mr. S. N. Stewart asserts in the "Scientific American" that there is no better sleep-guard than machinery. A person having a spring or electric or water motor to run her sewing-machine need only remove the needle, place the machine near the patient, and let it run.

THE new work by Dr. Charles Mercier on the "Nervous System and the Mind," which is intended to serve as an introduction to the "Scientific Study of Insanity," will contain an exposition of the new neurology as founded by Herbert Spencer and developed by Hughlings Jackson; an account of the constitution of the mind from the evolutionary stand-point, showing the ways in which it is liable to be disordered; and a statement of the connection between nervous function and mental processes as thus regarded.

A BAND of forgers of Swiss lake-dwelling antiquities have been detected and brought to trial, who appear to have been carrying on a quite extensive business. Among their deceptions was the installation of a spurious "horn age," which they effected by rudely carving objects of horn and planting them where they would afterward be excavated.

DR. ALBERT E. LEEDS, in the American Association, after referring to the rapid pollution which local water-supplies are undergoing in consequence of the growth of manufacturing towns, described what he called the "American System of Water Purification." It comprises three distinct features: Artificial aëration under pressure; precipitation of dirt, sewage, hardening constituents, and coloring-matters, by harmless precipitants; and mechanical filtration through filters capable of rapid reversal of current, with cleansing by mechanical means.

M. HILT, director of the coal-mines of La Wurm, near Aix-la-Chapelle, has devised a way for keeping the galleries clear from fire-damp by establishing a system of piping, through which the gas is sucked away into a reservoir. It can then be prepared and applied to any use for which carbureted hydrogen is suitable.

THE amount expended by the British people on alcohol appears to be diminishing with considerable regularity. The total for 1886 was £122,905,785, against £123,258,906 in 1885, and £146,288,759, the highest expenditure, in 1876. The diminished amount drunk is, however, still enormous, and it is worthy of remark that it is drunk by a diminishing number of persons, for the number who abstain totally, or drink exceedingly little, is steadily increasing.

THE efficiency of oil, when dropped on the water, to calm boisterous waves may now be regarded as established. It is astonishing how small a quantity of oil will answer the purpose. Admiral Cloné gives the amount as from two to three quarts an hour dropped from perforated bags hanging over the sides of the ship in positions varying with the wind. The oil, then, by its own outspreading, extending over the waves, forms a film of less than a two and a half millionth part of an inch in thickness; and this is enough to reduce breaking waves and dangerous "rollers" to unbroken undulations that are practically harmless. The oils that have been found most effective are seal, porpoise, and fish oils. Mineral oils, such as are used for illumination, are too light; but the lubricating oils are denser, and may be found sufficient.

MR. J. NORMAN LOCKYER, in his "Chemistry of the Sun," states his theory of dissociation by saying that "chemists regard matter as composed of atoms and molecules. The view now brought forward simply expands this series into a larger number of terms, and suggests that the molecular grouping of a chemical substance may be simplified almost without limit if the temperature be increased."

OBITUARY NOTES.

SIR JULIUS VON HAAST, whose name is closely associated with the record of geographical and geological investigation in New Zealand, died August 16th, in the sixty-eighth year of his age. He was a native of Bonn, Germany, and a student at its university. He was commissioned by an English company to go to New Zealand for the purpose of showing its suitability for German elements; and having arrived there in 1858, devoted the larger part of the rest of his life to scientific exploration. The results of this work are given in his "Geology of the Provinces of Canterbury and Westland," and in many papers in English scientific societies on the geology and physical geography of the islands. He discovered the Grey and Buller coal-fields, and several gold-bearing districts; instituted the Canterbury Museum, the first museum in the southern hemisphere, which has more than one hundred and fifty thousand labeled specimens, and founded the Philosophical Institute of Canterbury.

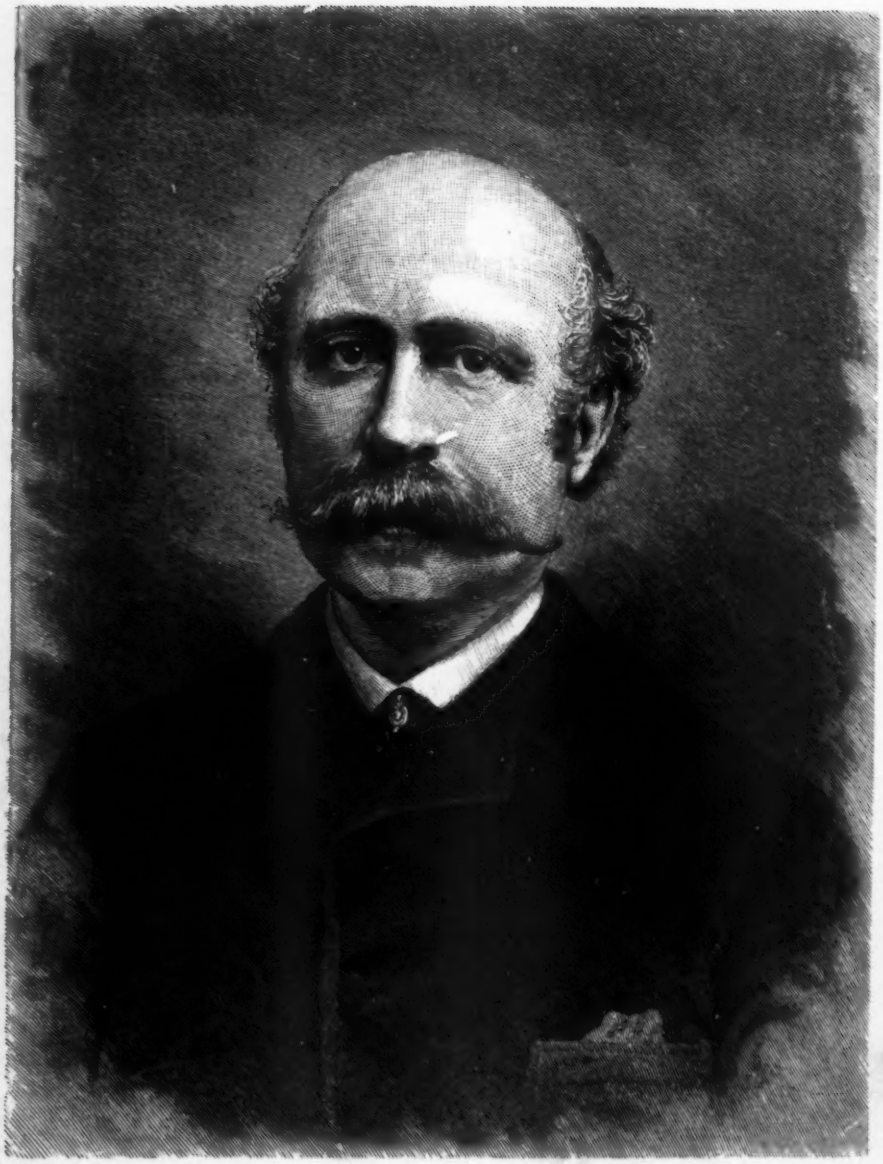
GUSTAV THEODOR FECHNER, Professor of Experimental Physics at the University of Leipsic, has recently died, in the eighty-seventh year of his age. He was best known by his work on psycho-physics, or the law of relation between the intensity of the stimulus and that of the resulting sensation, which he begun when he was nearly sixty years old, and which has become the center of a considerable literature. He was also active for many years in other branches of science, and was the author of a book of poems and a book of riddles.

PROFESSOR BALFOUR STEWART, Professor of Physics and Director of the Physical Laboratory in Owen's College, Manchester, England, died a few days before Christmas, in the fifty-eighth year of his age. He made his first start in commercial life, but soon turned his attention to science. His first scientific papers were published in the "Transactions" of the Royal Society of Victoria. He studied, experimentally, the radiation and absorption of heat, and for his labors received the Rumford medal in 1868. As director, for about ten years, of the Kew Observatory, he established the instruments for the self-registration of the direction and intensity of magnetic force. He was much interested in psychical research. Besides his "Elementary Practical Physics," and other properly scientific publications, he was the author of the curious books, "The Unseen Universe," and "Paradoxical Philosophy."

HERR AUGUST KAPPLER, from whose sketches of Dutch Guiana we have extracted an account of the monkeys of the country, recently died at Stuttgart, aged seventy-one years.

PROFESSOR CHARLES L. BLOXAM, Professor of Chemistry in King's College, London, died November 28th, in the fifty-sixth year of his age. He was distinguished in technical and analytical chemistry, and as the author of several hand-books of chemistry and metallurgy, and of an excellent text-book of chemistry.

DR. E. BALTZER, Professor of Mathematics in the University of Giessen, died November 7th, in the seventieth year of his age.



HENRY BRADFORD NASON.